SW Jemez Mts. Forest Restoration Project
Silviculture Specialist Report

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Introduction

A landscape assessment for the SW Jemez Mts. CFLRP was completed prior to this report. Reference material from the landscape assessment provided by David Lawrence, Santa Fe National Forest, was used in this report in describing existing and desired conditions.

This report describes the history of the forest in the area, and how past actions have created the existing condition. The existing condition is described both quantitatively and qualitatively. The desired condition is presented, based on recent research about the characteristics and capabilities of the forest. The difference between the two conditions leads to the proposed action, which is described as it relates to forestry activities. Finally, the effects of the forestry proposed action are discussed. The complete proposed action is in the EIS.

This report has four primary purposes:

1. To disclose the existing condition of forest vegetation and likely trends relating to stand density, insects and disease,

2. To provide information necessary to evaluate the goals and objectives of the Purpose and Need for action, and compare the effects of no action and alternatives to the proposed action on forest vegetation.

3. To provide supporting evidence/analysis that the proposed action and alternatives are consistent with the Forest Plan, laws, regulations, and policy.

4. To address issues related to vegetation management raised during scoping.

Laws applicable to this project

**Multiple-Use Sustained Yield Act of 1960.** Requires that national forest lands shall be administered for a variety of multiple uses, and that all resources shall be maintained as renewable in perpetuity for regular periodic output of several products and services at a sustainable level.

**Healthy Forest Restoration Act of 2003 (H.R.1904)** – Purposes pertinent to silvicultural application stated in Section 2 are: to reduce wildfire risk to communities and municipal water supplies through hazardous fuel reduction projects; to access and reduce the risk of uncharacteristically severe wildfire or insect and disease infestation; to enhance efforts to protect watersheds and address threats to forest and rangeland health (including wildfire) across landscape; to protect, restore, and enhance forest ecosystem components – biological diversity, threatened and endangered species habitat, enhanced productivity.

**National Forest Management Act of 1976 (NFMA),** The Santa Fe forest plan was developed in accordance with NFMA, as expressed by the 1982 planning rule.

While federal laws like the National Forest Management Act establish the regulatory requirements of forest management for federal agencies, the detailed direction that affects the project-level vegetation analysis being undertaken in this proposed action are contained in the forest plan (as amended) for the Santa Fe National Forest (USDA 1987). These include the goals, objectives, direction, and Forest-
wide and Management Area standards and guidelines referenced below that have relevance to the proposed action, as described below.

Management direction for riparian and timber related activities including integrating considerations for economics, water quality, soils, wildlife habitat, recreation opportunities, visual, and other values in project design.

Forest vegetation management direction in the Santa Fe National Forest Land Management Plan (USDA 1987) was amended in 1996 through a region-wide amendment of all forest plans in Arizona and New Mexico (USDA 1996).

**Mexican Spotted Owl**

A revised Mexican Spotted Owl (MSO) recovery plan was released in December 2012. The current Forest Plan (with 1996 amendment) is based on the original recovery plan. Alternatives 1, 3, and 4 are based on the new plan, with amendments to the Forest Plan to bring it into line with the new Recovery Plan. Alternative 5 uses the old 1995 Recovery Plan.

Some relevant portions of the old Recovery plan are:

- Provide three levels of habitat management- protected, restricted, and other forest and woodland types, to achieve a diversity of habitat conditions across the landscape. Protected areas include delineated protected activity centers (PACs), mixed conifer and pine-oak forests with slopes greater than 40% where timber harvest has not occurred in the last 20 years, and reserved lands which include wilderness, primitive areas, research natural areas, wild and scenic rivers, and congressionally recognized wilderness study areas. Restricted areas include all mixed-conifer, pine-oak, and riparian outside of protected areas. There is no pine-oak in the project area.

- **Protected Areas**
  
  - Allow no timber harvest except for firewood and fire hazard abatement in established PACs. Allow no timber harvest except for fire hazard abatement in mixed-conifer and pine-oak forests on slopes greater than 40% where timber harvest has not occurred in the last 20 years.
  
  - Within PACs, allow no treatment within the 100 acre core area surrounding the nest site. Use a combination of mechanical treatments (thinning trees up to 9” dbh) and prescribed fire to abate fire hazard in the remainder of the PAC outside the 100 acre “no treatment” area.
  
  - Large woody debris, snags, clumps of broadleaf woody vegetation, and hardwood trees larger than 10 inches at the root collar should be retained.

- **Restricted Areas**
  
  - Manage to ensure a sustained level of owl nest/roost habitat well distributed across the landscape. Create replacement owl/roost habitat where appropriate while providing a diversity of stand conditions across the landscape to ensure habitat for a diversity of prey species. Designate 25% of mixed conifer forest to be managed for restricted threshold habitat.
- Manage the mixed conifer threshold areas to retain or develop 150/170 square feet of basal area. 20% of the total stand density index must be trees greater than 18” dbh.

  o Emphasize uneven-aged management systems. However, both even-aged and uneven-aged systems may be used where appropriate to provide variation in existing stand structure and species diversity.

  o Save all trees greater than 24 inches dbh.

  o Encourage prescribed fire and fire for resource benefits to reduce hazardous fuel accumulation. Thinning from below may be desirable or necessary before burning to reduce ladder fuels and the hazard of crown fire.

  o Retain substantive amounts of key habitat components: snags over 18 “ dbh, down logs over 12” midpoint diameter, and hardwoods.

Some relevant portions of the new Recovery Plan are:

- Two levels of habitat management – Protected Activity Centers (PACs) and Recovery. PACs are 600 acres designated around each owl pair. Recovery includes mixed conifer, pine oak, and canyons. There is no pine-oak in the project area.
- Recovery habitat - 25% is designated as recovery Nest/Roost habitat. The other 75% is managed for other needs.
- The primary threat to the owl is stand-replacing wildfire.
- It is desirable to thin stands around PACs to reduce fire risk, but also acceptable to thin within PACs if necessary.
- In Recovery nest/roost habitat, keep or manage toward a minimum basal area of 120, with at least 12 trees/acre > 18”, and >30% of BA in the 12-18 and 18+” class.
- Cool fires may be allowed to back through core areas.
- Retain large trees.

**Northern Goshawk**

Elements that relate to northern goshawk (NGH) forest habitat apply to the forest and woodland communities described below that are outside of Mexican spotted owl protected and restricted areas:

- Manage for uneven-age forest stand conditions for live trees and retain live reserve trees, snags, downed logs, and woody debris levels throughout woodland, ponderosa pine, mixed conifer, and spruce-fir forest cover types. Manage for old age trees such that as much old forest structure as possible is sustained over time across the landscape. Sustain a mosaic of vegetation densities (overstory and understory), age classes and species composition across the landscape.

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1 diameter at breast height (dbh) – the diameter of the stem of the tree measured at 4 ½ feet above ground level (SAF 1998).
• Limit human activity in or near nest sites and Post-Fledgling Family Areas (PFAs) during the breeding season (March 1 through September 30).

• The distribution of vegetation structural stages for ponderosa pine and mixed conifer is 10% grass/forb/shrub (VSS 1), 10% seedling-sapling (VSS 2), 20% young forest (VSS 3), 20% mid-aged forest (VSS 4), 20% mature forest (VSS 5), 20% old forest (VSS 6). Distribution of habitat structures should be evaluated at the ecosystem management area level, at the midscale such as drainage, and at the small scale of site. (appendix A).

• Landscapes Outside Goshawk PFAs (hereafter referred to as Foraging Areas):
  o Maximum opening size is up to 4 acres with a maximum width of up to 200 feet. Retain one group of reserve trees per acre, of 3-5 trees per group, for openings greater than 1 acre in size.
  o Snags are 18 inches or larger dbh and 30 feet or larger in height, downed logs are 12 inches in diameter and at least 8 feet long, woody debris is 3 inches or larger on the forest floor. In the ponderosa pine forest leave at least 2 snags per acre, 3 large downed logs per acre, and 5-7 tons of woody debris per acre. In the mixed conifer forest type leave 3 snags per acre, 5 downed logs per acre, and 10-15 tons of woody debris per acre.
  o Balanced uneven-aged condition (stand area basis) with 40% canopy cover within the VSS 4-5-6 classes. Maintain average basal area from 50-60 square feet.

• Within Post Family Fledging Areas (PFAs):
  o Ponderosa pine: canopy cover for mid-aged forest (VSS 4) should average 1/3 60+% and 2/3 50+%. Mature (VSS 5) and old forest (VSS 6) should average 50+. Mixed conifer: canopy cover for mid-aged (VSS 4) to old forest (VSS 6) should average 60+. Balanced uneven-aged condition (stand area basis). Basal area averages from 70-80 ft², 2 snags per acre >18” diameter, 3 downed logs per acre 12” diameter and 8’ long, and 5-7 tons of woody debris >3” diameter.

• Within Nesting Areas:
  o Thin from below with non-uniform spacing and use hand tools and fire to reduce fuel loads. Lopping and scattering of thinning debris is preferred if prescribed fire cannot be used. Piling of debris should be limited. A high canopy cover (basal area equals or exceeds 120 ft²/acre) of mature to old age trees exists.

Old Growth
The Forest Plan recognizes that peoples’ understanding of old growth would change over time. It used the best information at the time to set some minimum criteria. The relevant parts are summarized here.
Table 1. Forest Plan old growth parameters.

<table>
<thead>
<tr>
<th></th>
<th>Ponderosa Pine</th>
<th>Mixed conifer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low site</td>
<td>High site</td>
</tr>
<tr>
<td>Live Trees/Acre in main canopy</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>DBH</td>
<td>14”</td>
<td>18”</td>
</tr>
<tr>
<td>Age</td>
<td>180</td>
<td>180</td>
</tr>
<tr>
<td>Snags</td>
<td>1/acre, 14” dbh, 15’ tall</td>
<td>1/acre, 14” dbh, 25’ tall</td>
</tr>
<tr>
<td>Down wood</td>
<td>2/acre, 12” diameter, 15’ long</td>
<td>2/acre, 12” diameter, 15’ long</td>
</tr>
<tr>
<td>Total Basal Area, sq ft</td>
<td>70</td>
<td>90</td>
</tr>
<tr>
<td>% Total Canopy Cover</td>
<td>40</td>
<td>50</td>
</tr>
</tbody>
</table>

The plan also describes old growth on pages 206-208. Direction in the Forest Plan that relates to old growth allocation includes:

- Seek to develop or retain old growth function on at least 20% of the naturally forested area, by forest type.
- All analyses should be at multiple scales—one scale above and one scale below the ecosystem management areas.
- Use information about pre-European settlement conditions at the appropriate scales when considering the importance of various factors.
- Thinning is permitted in stands being managed for old growth when the result will enhance attainment of the old growth characteristics.

**Issues**

One issue that was raised by the public was that of cutting large trees, and using diameter caps. There are some diameter caps that will be applied because of direction in the new and old Spotted Owl Recovery Plans:

Under the old plan - 9” dbh cap in MSO PACs and protected, 24” dbh cap in Restricted, keep at least 20 tpa > 18” dbh in target/threshold
Under the new plan – keep at least 12 tpa >18” dbh in PACs and nest/roost. It also says, “We encourage retention of large trees” (Table C.3 note 3 in U.S. FWS 2012).
Areas not described above would not have diameter caps, but it would be rare for a tree larger than 18” to be cut. Some reasons for cutting large trees would be:

- when invading seeps, springs, riparian areas, and wet meadows,
- where encroaching on grasslands,
- to promote aspen,
- to promote large oaks,
- to create within-stand openings,
- in stands that are heavily stocked with young, large trees
- to protect public safety
- to address insect and disease problems
- to help create uneven-age stands.

However, since there is a deficit of large trees, they would be retained whenever possible.

Another issue that was raised was that we were proposing to treat too many acres. We are proposing to treat approximately 1/3 of the total area mechanically. The intent of the project is to restore a large portion of the landscape, so that it can function as an ecosystem. Treating only a few acres will not address the problems of declining forest health and habitat quality. Also, experience shows that small, isolated projects are not effective in preventing large hot fires; projects must cover a large portion of the landscape in order to be effective. That is why this project was conceived, and designed to implement on a large scale.

**Methods**

The analysis of the existing condition and alternatives was based on: a) data from common stand exams (CSE), b) aerial photo interpretation, and c) a Nearest Neighbor (NN) imputation process that assigned stand exam data to stands without data, on the basis of spectral and topographic information (Crookston et al. 2002). Stands in ponderosa pine and mixed conifer cover types with CSE and NN-assigned data were modeled using the Forest Vegetation Simulator (FVS) (Keyser and Dixon, 2008) program to determine various attributes, and to analyze alternatives.

**Sources of Information**

**Vegetation Layer**

The planning area contains more than 2,770 stand polygons. Cover type was assigned to each stand based upon aerial photo interpretation. This layer was used as the base layer for the Nearest Neighbor (NN) imputation (see below). Cover type was then updated using stand exam and NN data where appropriate. The effects of the 2011 Las Conchas fire were taken into account by using the BARC (Burned Area Reflectance Classification map) layer to determine which stands had experienced stand-replacing fire, and were coded appropriately.

**Stand Exams**

There were 680 stand exams within and adjacent to the planning area, done in 2009-2010. Stand exam data was used in the NN run. Table 2 shows the stand exam coverage in the planning area by cover type. Within the ponderosa pine and mixed conifer cover types, approximately 47 percent of the area was covered with stand exams. In the pinyon-juniper cover type, approximately 6 percent was covered.
Table 2. Stand exam coverage by cover type within SWJM project area.

<table>
<thead>
<tr>
<th>Cover Type</th>
<th>Cover Type Acres</th>
<th>CSE Acres</th>
<th>%CSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponderosa Pine</td>
<td>44,918</td>
<td>20,229</td>
<td>45 %</td>
</tr>
<tr>
<td>Dry Mixed Conifer</td>
<td>22,896</td>
<td>11,141</td>
<td>49 %</td>
</tr>
<tr>
<td>Wet Mixed Conifer</td>
<td>3,910</td>
<td>2,277</td>
<td>58 %</td>
</tr>
<tr>
<td>Total</td>
<td>71,724</td>
<td>33,647</td>
<td>47 %</td>
</tr>
</tbody>
</table>

Walk-through Surveys

The TEAMS silviculturist, Rob Schantz, visited the planning area in November, 2011 to conduct walk-through surveys of stands and make general observations. Items noted during these visits were species composition, size classes, insect and disease occurrence, tree regeneration, understory vegetation, harvest systems considerations, and road access. This reconnaissance information was used, along with stand exam/NN data summaries, GIS layers, and aerial photography, to develop the proposed action treatment units and treatment needs, and recommendations.

GIS Layers

The following GIS layers were used in development of the proposed action, existing condition, and effects analysis: vegetation layer, roads, streams, 2010 ECW photo mosaic, Mexican spotted owl PACs, MSO target/threshold stands, MSO nest/roost stands, northern goshawk PFAs and nest stands, and a 10 meter DEM.

Analysis Methods

Nearest Neighbor

A computer program called Nearest Neighbor (NN) was used to assign stand exam data (reference stands) to the stands without stand exam data (Crookston et al. 2002). NN analysis uses satellite imagery (2010 LandSat TM data), spatial relationships, and topographic information to match target stands without data to the most similar reference stand with data. Tree data from the reference stand is then assigned to the target stand without data. Target stands with a statistically poor match to any reference stands were not assigned stand exam data, and photo interpretation (PI) was used as the data source - since these stands did not have tree data, they were not modeled in FVS. Table 3 displays the acres with adequate NN matches or reference data (CSE), and the number of acres using PI within the ponderosa pine and mixed conifer cover types. Since there was very little reference data for the piñon-juniper cover type (about 20 stand exams), NN imputation was not used as a data source- only CSE (5 percent of cover type area) and PI (95 percent of cover type area) data was used.
Table 3. Data sources for the ponderosa pine and mixed conifer cover types.

<table>
<thead>
<tr>
<th>Cover Type</th>
<th>CSE Acres</th>
<th>NN Acres</th>
<th>PI Acres</th>
<th>Total Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponderosa Pine</td>
<td>20,229</td>
<td>20,549</td>
<td>2,813</td>
<td>43,591</td>
</tr>
<tr>
<td>Dry Mixed Conifer</td>
<td>11,141</td>
<td>10,234</td>
<td>575</td>
<td>21,950</td>
</tr>
<tr>
<td>Wet Mixed Conifer</td>
<td>2,277</td>
<td>1,481</td>
<td>152</td>
<td>3,910</td>
</tr>
<tr>
<td><strong>Total Acres</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>69,451</strong></td>
</tr>
</tbody>
</table>

The statistics for the NN run indicate that 70 percent of the stands were well represented by the imputation process, with 30 percent not having similar reference stands (statistically poor). The 70 percent figure corresponds well to the ponderosa pine and mixed conifer cover types which comprise approximately 60 percent of the planning area and had approximately 47 percent coverage with stand exams. Stands with a statistically poor match were not assigned surrogate stand exam data, and these were primarily in the piñon-juniper cover type. Only 3 to 6 percent of the stands in the ponderosa pine and mixed conifer cover types had a poor match due to the high number of reference stands, and photo interpretation was used as the data source for these stands.

**Forest Vegetation Simulator (FVS)**

The Central Rockies variant of the FVS model was used for this project. FVS is a model used for predicting forest stand dynamics that is used extensively in the United States. Forest managers have used FVS extensively to summarize current stand conditions, predict future stand conditions under various management alternatives, and update inventory statistics. It models tree growth, natural occurrences, and management actions.

Current and future estimates of stand density metrics and stand density index (SDI) were computed from raw stand exam data entered into the FVS program. All plots were used, and there was no manipulation of the raw data. Maximum SDI values by species were those used by the FVS program, with the exception of ponderosa pine which was set to 450, based on recent research (Long and Shaw 2005). Other species are as follows: Douglas-fir-560, White Fir-735, Blue Spruce-735, and Englemann Spruce-735. Maximum values used to compute percentage of maximum SDI for each cover type were based on a weighted average of the assumed historic species composition. Table 4 presents the derived maximum SDI values by cover type and the assumed ratio of species.

Forest vegetation treatments were simulated by modeling selective cutting and low thinning (in some stands) to the average residual density from Table 9, using SDI as the thinning parameter. Uneven-age management by group selection was assumed, through creation of regeneration openings for VSS 1 and release of existing regeneration for VSS 2. Simulations modeled the intermediate treatments over the 80 percent of the areas outside the potential VSS 1-2. Ponderosa pine was favored in the residual stand by giving white fir and Douglas-fir a priority for removal. Stand metrics for pre- and post-treatment were computed for trees per acre, basal area per acre, and stand density index. Volumes for products removed in thinning were based on a 9 inch minimum merchantable dbh for sawlogs, and a 5” minimum dbh for non-sawlog products. Biomass was estimated using a conversion factor of 1.2 bone-dry tons per hundred cubic feet of stem volume for clean wood chips.
Fuel treatment effects from piling and burning were assumed to last for 5 years. Output potential fire metrics from FVS-FFE included canopy bulk density, canopy base height, flame lengths, crowning and torching index.

Existing snags were computed for ponderosa pine and mixed conifer cover types for 12 and 18 inch dbh and larger classes from dead trees recorded on the stand exams. Future snag levels for these size classes were estimated from the FVS model, and assuming one-third of existing snags would be lost in treated areas due to operations. Minimum size of dead trees recorded on stand exams was 10 inches dbh and 10 feet tall.

Dwarf mistletoe ratings (DMR) for stands were computed by the FVS model, which computes an average rating based on individual tree ratings of all trees of the same species in a stand.

**Table 4. Maximum SDI values by cover type.**

<table>
<thead>
<tr>
<th>Cover Type</th>
<th>Maximum SDI</th>
<th>Species Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponderosa Pine</td>
<td>450</td>
<td>100% PP</td>
</tr>
<tr>
<td>Dry Mixed Conifer</td>
<td>472</td>
<td>80% PP: 20% DF</td>
</tr>
<tr>
<td>Wet Mixed Conifer</td>
<td>636</td>
<td>10% PP: 40% DF: 50% WF-BS</td>
</tr>
</tbody>
</table>

**Limitations**

Limitations of the FVS model in this instance include the following:

1. Limited ability to simulate desired stand conditions in terms of heterogeneity
2. The model is a density-dependent model which limits the ability to model openings created for uneven-aged management using group selection.
3. Under-prediction of crowning potential versus empirical observations (Cruz and Alexander 2010)
4. Lack of establishment of natural regeneration in the CR variant, leading to overestimation of canopy base height in the future
5. Mortality estimates from FVS-FFE are based on the potential fire type (surface, crown, conditional crown) and are best used as a means to compare the effects of alternatives rather than absolute values.
6. Mortality estimates for future snags are based on stand density and self-thinning rules in the model, and do not reflect the high incidence of dwarf mistletoe found in the project area. Therefore, future snags are underestimated in the model projections.

**Forest Cover Types/Size Classes/Density**

Forest cover types, size classes, and density were determined from stand exam information (CSE/NN), field visits, and aerial photo interpretation. Mexican spotted owl (MSO) restricted habitat was computed in the FVS model through a computation that determined the percentage of focal tree species for owl
habitat (Vandendriesche, pers. comm.). Where PI was the data source due to poor NN statistics or non-forest types, cover type was taken from the existing vegetation layer.

**Stratification of Forested Habitat**

All forested habitat was stratified to meet analysis requirements in the forest plan for Mexican spotted owl (MSO) and northern goshawk NGH as displayed below.

**Total Analysis Area**

SWJM Planning-Analysis Area: 109,311 Acres NFS Lands ➔ go to Forested/Non-forested

**Forested/Non-forested**

Forested: 105,251 acres ➔ go to Forested Types
Non-forested: 4060 acres

**Forested Types**

PP-MC: 69,451 acres ➔ go to Habitat Strata
P-J/Juniper Woodlands: 34,622 acres
Hardwoods types: 1139 acres

**Habitat Strata**

MSO Habitat: 25,960 acres
NGH Habitat: 43,491 acres

**Development of Silvicultural Treatments**

Treatments were assigned using stand exam data/MSN, field reconnaissance information, cover type information, and a 2010 orthophoto mosaic. The following steps outline the process used to develop treatments:

1. Stand exam data was linked to polygons in layer SWJM_BaseVegetation_Site (vegetation layer). Polygons without a stand exam were assigned a surrogate stand exam from a nearest neighbor (also called most-similar-neighbor or MSN) imputation. Non-forest types were evaluated using the cover type attribute in the vegetation layer and through interpretation of the 2010 orthophoto mosaic.

2. For all polygons with stand exam or MSN-surrogate stand exam data, a preliminary treatment was assigned based on queries of stand summary attributes for the year 2012 generated by the Forest Vegetation Simulator (FVS). Dominant species, total basal area, basal area by size class and species, and trees per acre 18 inches dbh and larger were the main attributes used.

3. For non-forest types and cover types without representative data, a preliminary treatment was assigned using the cover type attribute in the vegetation layer.

4. Visual inspection of the 2010 orthophoto and site specific data checks, as well as notes from stand reconnaissance, were used to validate treatments. Each of the 2,777 polygons in the vegetation layer was assigned a treatment from the SWJM proposed action description of treatments.
5. The vegetation layer was intersected with goshawk PFAs, MSO PACs, and the Las Conchas and Guacamalla fires. The area within the fire perimeters was evaluated for burn severity and assigned an appropriate treatment.

6. The layer created in step 5 was intersected with the 40 percent slope break from the 10 meter Digital Elevation Model. Mechanical treatments with product removal on slopes greater than 40 percent were changed to a prescribed fire treatment, except within MSO PACs (stayed as a small tree pile/burn), and within the wet mixed conifer types (became no treatment).

Analysis of Wet Mixed conifer seral stages

As the IDT worked through the analysis process, a question came up about whether there is enough aspen in the project area. Aspen is considered to be the early seral stage of the wet mixed conifer cover type. The following coarse analysis was done to get an idea of the proportion of seral stages within the WMC. The stands in the WMC were labeled “early”, based on photo interpretation, if they were open or had a lot of aspen. The stands were labeled “late” if they qualified as old growth, or had predominantly VSS 5 or 6. All other stands were labeled “mid”. Also, all stands in the “aspen” cover type layer were considered to be early successional WMC. The BARQ map for the Las Conchas fire was examined, and it was estimated that about 600 acres had been wet mixed conifer, burned in the “severe” category, and are now assumed to be aspen. These acres were totaled, and the proportion of each stage was calculated.

Las Conchas = 600 acres + Aspen CT = 754 acres + WMC CT = 3909 acres = 5,263 acres total.

Early =1,591 acres = 30%, Mid = 1,790 acres = 34%, late = 1,882 acres = 36%.

Alternative 5

When alternative 5 was added, the entire analysis was re-run. For alternative 1, the new definition of nest/roost recovery habitat was modeled to see which stands met it. They were mostly different stands from the ones that met the old definition of target/threshold stands; there was little overlap. For Alt 1, a model run was done using 120 basal area and 18” cap in PACs and nest/roost. For alternative 5 a run was done using a 9” cap in PACs and 150 basal area in target/threshold. The results are displayed in Table 16.

Existing Condition

Influences on Existing Condition

Historic Timber Harvest

Most of the ponderosa pine stands in the assessment area were logged in the early 1900s. Intensive railroad logging occurred throughout the Jemez Mountains from 1924 to 1941. Virgin, Holiday and Stable mesas were logged between 1934 and 1936. Those heavy harvests removed most of the old-growth trees. Truck logging continued less intensively, until the lands came under Forest Service ownership in the 1960s (Elliott 1997, USDA 1992). Logging almost ceased in the early 1990s. Then, WUI treatments began in the mid-1990s, which involved cutting small trees in limited areas. There was a wet period in the 1980’s which caused a flush of new trees, which are now pole-size and dense. Some of the pine stands on NFS land have had second entries, ranging from regeneration harvests, where most or all of the remaining large trees were removed, to selection harvests, where individual trees were selectively
removed. Ponderosa pine has been commercially favored since the earliest logging, so other species such as Douglas-fir and white fir are now often what is left in the stands. Precommercial thinning, firewood cutting and prescribed burning activities have since occurred in many areas, while no activities have occurred in other areas.

Though extensive logging has occurred in the Jemez Mountains, some ponderosa pine stands have escaped past harvesting. These stands are scattered about, but typically found in drainages and on steep slopes. The large, old tree component is much more substantial in these stands than previously logged stands. Old trees in these stands (as well as residuals in some logged stands) can be as old as 400 years or more. Although the old trees have not been affected by harvesting, the effects of forest density, climate, livestock grazing and fire suppression are not dissimilar to logged stands in the Jemez Mountains. Regeneration has created multi-storied stands with dense canopy cover and sparse surface cover of grass.

**Fire Suppression/Grazing**

In addition to past harvest, livestock grazing and fire suppression have influenced the existing condition of ponderosa pine stands. Generally favorable moisture, reduced competition from grasses, and protection from fire have all enabled tree regeneration to thrive. As a result, most stands now are dominated by trees that originated in the early 1900s, though residual old individuals and subsequent periodic regeneration have created uneven-aged conditions in many stands. The current dense stocking levels increase competitive interactions between individual trees, resulting in slowed growth, reduced vigor, and increased susceptibility to damage or mortality from insects and diseases. The overstocking also increases the hazard of uncharacteristically severe wildfires.

Species composition has changed considerably in many of the ponderosa pine stands in the planning area, because of the preferences of early loggers for ponderosa pine. Also, because canopy cover is high, much of the regeneration is shade tolerant species, such as white fir. In addition, fire suppression has reduced the evolutionary advantage of ponderosa pine as a fire tolerant species, furthering the success of other species. As a result, proportions of other species, especially Douglas-fir and white fir, have increased relative to ponderosa pine on the landscape. In many cases, stands that were dominated by ponderosa pine have a greater proportion of Douglas-fir, limber pine, and white fir.

**Insects and Disease**

Insect levels have been quite variable over the years. The following table shows the number of acres infested for the last 16 years. The number of acres infested grew from 2003 to 2009, then declined. By far the most acres are impacted by western spruce budworm, which attacks Douglas-fir, until 2013, when there appears to be an outbreak of Ips and western pine beetle.
Table 5. Acres of Infestation by Insect, by Year

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Aspen Defoliation</th>
<th>Douglas-Fir Beetle</th>
<th>Fir Engraver</th>
<th>Ips Engraver Beetles</th>
<th>Pinyon Ips</th>
<th>Western Pine Beetle</th>
<th>Western Spruce Budworm</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>19</td>
<td></td>
<td>23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>176</td>
</tr>
<tr>
<td>1999</td>
<td></td>
<td></td>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>106</td>
</tr>
<tr>
<td>2000</td>
<td>114</td>
<td></td>
<td>23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>343</td>
</tr>
<tr>
<td>2001</td>
<td>115</td>
<td></td>
<td>57</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2,450</td>
</tr>
<tr>
<td>2002</td>
<td>193</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>858</td>
</tr>
<tr>
<td>2003</td>
<td>14</td>
<td>305</td>
<td>383</td>
<td>52</td>
<td>27</td>
<td>10</td>
<td></td>
<td>792</td>
</tr>
<tr>
<td>2004</td>
<td>82</td>
<td>728</td>
<td></td>
<td></td>
<td>195</td>
<td>120</td>
<td></td>
<td>1,125</td>
</tr>
<tr>
<td>2005</td>
<td>383</td>
<td>303</td>
<td>323</td>
<td></td>
<td>13</td>
<td>1,208</td>
<td></td>
<td>2,229</td>
</tr>
<tr>
<td>2006</td>
<td>348</td>
<td>222</td>
<td>32</td>
<td></td>
<td>117</td>
<td>1,361</td>
<td></td>
<td>2,080</td>
</tr>
<tr>
<td>2007</td>
<td>286</td>
<td>88</td>
<td>8</td>
<td>345</td>
<td></td>
<td></td>
<td>2,902</td>
<td>3,823</td>
</tr>
<tr>
<td>2008</td>
<td>113</td>
<td>14</td>
<td></td>
<td></td>
<td>236</td>
<td>2,851</td>
<td></td>
<td>3,338</td>
</tr>
<tr>
<td>2009</td>
<td>92</td>
<td>1</td>
<td></td>
<td></td>
<td>2</td>
<td>4,948</td>
<td></td>
<td>5,107</td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>2,791</td>
<td></td>
<td>2,961</td>
</tr>
<tr>
<td>2011</td>
<td>260</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>3,306</td>
<td></td>
<td>4,031</td>
</tr>
<tr>
<td>2012</td>
<td>227</td>
<td>50</td>
<td>21</td>
<td>26</td>
<td>340</td>
<td>1,438</td>
<td></td>
<td>2,126</td>
</tr>
<tr>
<td>2013</td>
<td>264</td>
<td>242</td>
<td>568</td>
<td></td>
<td>1,139</td>
<td>220</td>
<td></td>
<td>2,432</td>
</tr>
</tbody>
</table>
Dwarf mistletoes (*Arceuthobium* species) and/or True mistletoes (*Phoradendron* species) infect ponderosa pine and Douglas-fir in the planning area. These pathogens parasitize water and nutrients from the host tree and disturb physiological process, which reduces growth and vigor, causes distortions such as witches’ brooms, and increases susceptibility to environmental injury or insect attacks. Dwarf mistletoe infection is typically patchy within stands and across the landscape. Infections spread short distances to adjacent trees, so changes in occurrence on a landscape must be measured on a long-term scale, rather than annually (USDA 2008). The impact of infection on individual trees depends on many factors, including location and extent of infection, site quality and tree size.

During field reconnaissance, dwarf mistletoe was common in ponderosa pine stands all across the assessment area. It is widespread on Schoolhouse, Stable, Holiday, and Virgin Mesas, though severity was generally moderate to low. Some infection centers are small and manageable, even with uneven-aged silviculture systems. Other infections are severe, long-established, and larger; therefore, uneven-aged forest management may not be a viable objective on these sites. Stand exam data for the ponderosa pine and dry mixed conifer cover types, where ponderosa pine is the predominant species, indicate that approximately 57 percent of the stands have some degree of dwarf mistletoe infection. Table 6 shows that most of the infection would be considered light to moderate on a stand-level basis, where the rating for individual trees is averaged over the entire stand. This data shows that most infected stands have a component of lightly and/or un-infected trees that could be managed towards desired conditions for stand structure, density, and species composition, but also shows that dwarf mistletoe will be an important consideration in development of site-specific prescriptions during implementation. Based upon current science (Conklin and Fairweather 2010), stands with characteristic levels of dwarf mistletoe infection (less than 20% of host trees or 25% of a stand area) are suitable for managing as uneven-aged forests; those with greater levels of severity should be managed using even-aged silvicultural methods.

### Table 6. Stand DMR levels for PP-DMC cover types (stands with CSE data only).

<table>
<thead>
<tr>
<th>DMR Level</th>
<th>Acres</th>
<th>% PP-DMC Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy</td>
<td>2,122</td>
<td>7%</td>
</tr>
<tr>
<td>Moderate</td>
<td>7,536</td>
<td>24%</td>
</tr>
<tr>
<td>Light</td>
<td>21,711</td>
<td>69%</td>
</tr>
<tr>
<td>Totals</td>
<td>31,370</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Root diseases** are another common pathogen, but one which is not readily visible. The most abundant root diseases in this area are likely armillaria (*Armillaria* spp.) and annosus (*Heterobasidion annosum*). They are most common in mixed conifer forests, but can infect many species, both coniferous and deciduous. Individual trees infected with root disease suffer increased susceptibility to insect attacks, as well as higher probability of windthrow, which is often when a root disease is identified. Root diseases spread slowly and survive as decayers on dead woody material. As such it is a chronic condition that remains on site and can be exacerbated by harvesting. Root diseases are at endemic levels in the project area. They don’t require any special treatment at this time.

**White pine blister rust** is caused by the fungus *Cronartium ribicola*, introduced from Asia around 1910 into western British Columbia. As the name implies, it infects white pines, including southwestern white pine and limber pine (*Pinus flexilis*). Occurrence and severity of the disease is much higher in northern latitudes, but it appears to be spreading in the southwest. The Santa Fe National Forest supports the largest population of white pines in Region 3, but currently has very little blister rust. The first, and
currently the only, white pine blister rust infection center known on the forest was discovered in the assessment area in 2007 (Conklin et al 2009). It is expected to spread over time, with intensity and severity dependent on site suitability. Warmer, dryer, lower elevation slopes are expected to have lower infection levels than colder, wetter, and higher elevation sites, including canyons and drainages. No management options currently exist to mitigate the impacts of this disease on host species. Genetic conservation of white pines is the most likely means of ensuring future viability of southwestern white and limber pines. Therefore, white pine will favored as leave tree in prescriptions.

__________________________

Mistletoe/dwarf mistletoe and root disease effects are slow-acting and difficult to measure. On the other hand, effects of insects are typically visible in short time frames, making them easier to monitor and evaluate. The Forest Service Region 3 Forest Health staff completes annual insect and disease aerial detection surveys, which are mapped and sampled for accuracy. That source is the most reliable and quantitative source available for displaying the impacts of insects and pathogens in the assessment area. Data for the past 16 years of detection surveys was mapped and evaluated for the assessment area (Table 5).

In terms of land area affected, western spruce budworm (Choristoneura occidentalis) has been the most widespread and chronic pest in the assessment area. Host species include true firs, Douglas-fir, and spruce, with white fir seemingly preferred. Spruce budworm defoliates host trees from the top down. Multi-storied stands are typical and provide favorable conditions for the larvae to feed upon. Repeated defoliation has occurred in much of the affected area, resulting in top-kill of some larger trees and mortality of smaller trees, especially seedlings and saplings in the understory. Some mortality of larger trees is attributed to repeated defoliation, either directly by western spruce budworm, or indirectly where bark beetles have attacked weakened individuals. Most of the spruce budworm activity has occurred in the VCNP, though much of Paliza Canyon has seen repeated defoliation. Also, San Pedro Parks Wilderness, just outside the project area, has had repeated heavy defoliations. If warm, dry conditions continue, many trees could eventually die, leading to a change in species composition.

Piñon ips (Ips confusus) reached epidemic proportions in the early 2000s as a result of ongoing drought and high temperatures. The effect on piñon in the assessment area is not well known because the aerial detection survey flights did not consistently include the piñon-juniper types and limited reconnaissance has been completed. However, the epidemic peaked in years 2002, 2003, and 2004 with widespread mortality of piñon, especially on lower quality sites. To the southeast of the assessment area, the NM Zone Forest Health staff flew the piñon-juniper in the Cochiti area and produced a report summarized as follows: across 42,000 acres, an estimated 4 million piñons were killed - two-thirds of all piñon in the area. Survivors were generally less than 3 inches in diameter and 30 to 55 years old. Juniper was unaffected and the species composition shifted from less than 60 percent juniper to more than 80 percent juniper (2003 presentation by NM Zone I & D personnel).

Ponderosa pine is susceptible to attack by a variety of beetles, though western pine beetles (Dendroctonus brevicomis) and Ips engraver beetles (Ips spp) are the primary mortality agents. Western pine beetles typically attack mature/large, low-vigor trees, while engraver beetles prefer smaller-diameter slash and damaged trees. During these drought years, however, Ips engravers commonly attacked low-vigor smaller tree boles and larger tree crowns, causing mortality in both size classes. Throughout the drought years surveyed, ponderosa pine mortality impacted small pockets and scattered individuals; it never approached epidemic proportions as the piñon did. In 2013, there was a big increase in Ips, associated with the Las Conchas fire. There was also a big increase in western pine beetle. Much of the impact is at lower elevations, where trees may already be stressed from drought. Ponderosa pine mortality was significantly higher state-wide in 2013, so there is probably a larger cause, such as drought.
Bark beetle hazard is moderate to high over much of the planning area (Table 7). In general, ponderosa pine stands that have an average diameter greater than 12 inches are hazard-rated based upon stand basal area per acre (BA): BA greater than 120 ft²/acre are considered at high hazard to bark beetle attack; BA of 80 – 120 ft²/acre are considered moderate hazard; and BA less than 80 ft²/acre are considered low hazard (McMillin 2004). Table 7 shows that approximately 89 percent of the ponderosa pine and dry mixed conifer cover types, are in a density condition which renders them susceptible to bark beetle activity and mortality (moderate to high hazard). Therefore, it is important to do thinning in order to save these stands from large-scale mortality.

Table 7. Bark beetle hazard in PP-DMC cover types (stands with CSE or NN data)

<table>
<thead>
<tr>
<th>Bark Beetle Hazard</th>
<th>Acres</th>
<th>% of PP-DMC Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>53,681</td>
<td>86%</td>
</tr>
<tr>
<td>Moderate</td>
<td>1,989</td>
<td>3%</td>
</tr>
<tr>
<td>Low</td>
<td>6,483</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>62,153</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Higher elevation species seem to respond more slowly to the effects of the drought. As a result, there is a longer lag time before mortality increases. Douglas-fir bark beetle (*Dendroctonus pseudotsugae*) and fir engraver beetle (*Scolytus ventralis*) activity was minimal before 2003 and peaked in 2004 and 2005, respectively. Mortality was typically confined to small pockets of only a few trees. Mortality of Douglas-fir ranges across all sizes of mature and old trees. White fir mortality is typically in the young to mature trees and is found often on drier sites where ponderosa pine and Douglas-fir are dominant.

Quaking aspen are host to western tent caterpillars (*Malacosoma californicum*). They are endemic to the area and feed on other species as well, but are most visible throughout the range of aspen. Larvae feed on the leaves of aspen and populations may reach levels sufficient to completely defoliate stands of aspen, such that it looks like winter during the growing season. Aspen are resilient to the defoliation, but repeated defoliations can cause growth loss, top-kill and tree mortality. Repeated defoliation appears to be fairly limited within the assessment area, though aspen decline (mortality) has been mapped in recent years. Aspen decline is gaining attention across the West. Its’ cause may be drought, and there is growing concern that permanent loss of aspen clones is occurring on the landscape. It will be important to monitor aspen populations, so we can respond to large-scale die-off should it occur. It is also important to keep many clones of aspen scattered all over the landscape, so not all aspen is lost. The amount of defoliation has been fairly steady over the last 3 years.

**Forest Composition**

The Southwest Jemez Mountains landscape is noted for its diversity and includes piñon-juniper, ponderosa pine, mixed conifer, aspen, and other minor forest ecosystems. Grasslands, meadows, wetlands and riparian areas are also found across the landscape. The percentages of the vegetative types found in the area are shown in Table 8 below.
Table 8. Vegetation cover types in the analysis area (NFS lands).

<table>
<thead>
<tr>
<th>Cover Type</th>
<th>Acres</th>
<th>% Planning area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponderosa Pine</td>
<td>43,591</td>
<td>39.9%</td>
</tr>
<tr>
<td>Piñon/Juniper</td>
<td>34,497</td>
<td>31.6%</td>
</tr>
<tr>
<td>Dry Mixed Conifer</td>
<td>21,950</td>
<td>20.1%</td>
</tr>
<tr>
<td>Wet Mixed Conifer</td>
<td>3,910</td>
<td>3.6%</td>
</tr>
<tr>
<td>Burned (Las Conchas fire)</td>
<td>2,092</td>
<td>1.9%</td>
</tr>
<tr>
<td>Grassland</td>
<td>938</td>
<td>0.9%</td>
</tr>
<tr>
<td>Aspen</td>
<td>755</td>
<td>0.7%</td>
</tr>
<tr>
<td>Burned (other recent fire)</td>
<td>524</td>
<td>0.5%</td>
</tr>
<tr>
<td>Oak Woodland</td>
<td>379</td>
<td>0.3%</td>
</tr>
<tr>
<td>Gambel Oak (shrub)</td>
<td>208</td>
<td>0.2%</td>
</tr>
<tr>
<td>Rockland, talus, scree</td>
<td>241</td>
<td>0.2%</td>
</tr>
<tr>
<td>Juniper Woodland</td>
<td>118</td>
<td>0.1%</td>
</tr>
<tr>
<td>Strip mines, quarries, gravel pit</td>
<td>57</td>
<td>0.1%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>109,311</strong></td>
<td><strong>99.9%</strong></td>
</tr>
</tbody>
</table>

**Pinyon-Juniper Cover Type**

Piñon-juniper woodlands are one of the most prominent vegetation types, covering approximately 32 percent of the NFS land in the planning area, all of it in the southern portion. It is a diverse type that ranges from open savannas to dense-canopy woodlands, influenced by many factors including biogeophysical factors and climate, as well as past and current land use. Romme et al. (2008) defines three piñon-juniper types described below.

1. On lower elevations with deeper soils and gentle topography, piñon-juniper savannas maintain sparse canopy cover and relatively continuous grass cover. The grass cover historically supported frequent, low-severity fires. Some of these savannas were previously grasslands, but have successfully seeded in with juniper and/or piñon trees as a result of changes in climate, disturbance of fire regime, and/or effects of grazing, both by removing fine fuels, and by reducing competition from grasses. Similarly, many of the historic savannas have experienced ingrowth of piñon and/or juniper and are better described as open woodland. The continuous grasses are the key feature for this savanna classification.

2. Shrub woodlands have a successional character that is dominated by shrubs but supports a density of tree cover that fluctuates with climate and disturbance. Surface cover is highly variable as typical sites range from deep valley-bottom soils to shallow rocky soils on steep slopes. Romme et al (2009) describes this type as areas of potential expansion and contraction of the piñon-juniper type.
3. Persistent woodlands are found on shallow upland soils that favor piñon and juniper over grasses and other non-woody vegetation. Canopy cover varies depending on site. Understory can include grasses, forbs, and/or shrubs, but is not continuous and often displays bare ground. Fire likely was infrequent, though stand replacing. Other environmental factors, such as the Ips beetle epidemic a few years ago, play a significant role in stand dynamics.

The project area contains the second and third types; they are functioning within characteristic ecological conditions, and need little treatment.

Land use in piñon-juniper woodlands has influenced vegetation conditions at least since the introduction of livestock grazing, which began as early as the early 1700s in some parts of the Jemez Mountains (Touchan et al. 1995). In some cases, livestock grazing encouraged ingrowth of woody plants by reducing competition from grasses. In other cases, the hoof action combined with reduced surface cover led to increased runoff and erosion of shallow soils on broken ground. Piñon and juniper trees can live for a few hundred years on these sites, which are typically all-aged. Wood cutting is common in this area, though it historically targeted dead trees.

The density of piñon-juniper woodlands has increased in much of its range over the past century or more. The range of piñon-juniper woodlands has likely increased as well, with expansion into grasslands. However, large-scale, natural decreases in piñon-juniper have occurred in recent times also. A combination of environmental factors—drought, insects, and high temperatures—killed millions of piñon trees in the four corners region, including portions of the SW Jemez Mts assessment area, in the early 2000s (Romme et al. 2009). However, new trees are regenerating.

**Ponderosa Pine Cover Type**

Ponderosa pine (*Pinus ponderosa*) is the dominant forest type in the project area, comprising approximately 40 percent of NFS lands. Ponderosa pine stands in the assessment area range from lower elevation, dry sites where they are transitional with piñon-juniper woodlands, to higher elevation, moist sites where they grade into mixed conifer. Subdominant trees associated with this type are two-needle piñon (*Pinus edulis*), one seed juniper (*Juniperus monosperma*), Rocky Mountain juniper (*Juniperus scopulorum*) and Gambel oak (*Quercus gambelii*). Predominant understory vegetation includes shrubs such as oaks (*Quercus* spp.), New Mexico locust (*Robinia neomexicana*), and kinnickinnick (*Arctostaphylos uva-ursi*); and bunchgrasses such as Arizona fescue (*Festuca arizonica*), pine dropseed (*Blepharoneuron tricholepsis*), mountain muhly (*Muhlenbergia montana*), and blue grama (*Bouteloua gracilis*). Ponderosa pine regenerates most successfully in openings. Ponderosa pine stands are established and maintained by fires, harvest, or other disturbances that favor shade intolerant species.

**Mixed Conifer Cover Types**

Mixed conifer forest types (dry mixed conifer and wet mixed conifer) comprise approximately 24 percent of the NFS lands within the project area. The mixed conifer type is variable and consists of a mixture of species including Douglas-fir, white fir, ponderosa pine, blue spruce, aspen, limber pine, Rocky Mountain juniper, and Gambel oak. Mixed conifer is a transitional forest type that ranges from warm and dry to cool and moist. For consistency with wildlife habitat analysis, the definition of mixed conifer according to the Mexican spotted-owl recovery plan will be used in this report (USDI 1995). This definition includes stands within Douglas-fir, white fir, limber pine and blue spruce habitat series, except those considered “pure” for a species other than Douglas-fir, white fir, limber pine, or blue spruce, or stands with more than 50 percent of the basal area in quaking aspen.

Currently, the mixed conifer type in the assessment area includes both even-aged and uneven-aged stands. Historically, the dry mixed conifer stands were uneven-aged due to frequent disturbance. Heavy regeneration events, periodic harvesting, and reduced natural disturbances have created stand conditions in many cases dominated by one or two age classes. However, the presence of a residual overstory and
the periodic regeneration of shade tolerant species may maintain uneven-aged character in stands. In both dry and wet mixed conifer, regeneration is associated with disturbance, including fire, insects, disease, wind-throw, drought, etc. Aspen, ponderosa pine and other shade intolerant species are maintained in mixed conifer through disturbance. The increase of shade tolerant species in mixed conifer stands can be attributed to reduced disturbances, particularly fire occurrence.

**Warm, dry mixed conifer** is associated with the lower elevations and dryer southerly aspects within the Douglas-fir and white fir series. Most of the mixed conifer in the planning area would be considered dry mixed conifer. Warm, dry mixed conifer is characteristically dominated by ponderosa pine and Douglas-fir in the overstory, but currently, in some locations, shade tolerant species, such as white fir and blue spruce, are becoming dominant due to fire suppression and other past management practices. White fir may be codominant in the overstory, but is also often dense and dominant in the understory. Other species are minor components, and aspen is often found in small amounts in drainages, north aspects, and other wetter locales in the stands. Historically, the dry mixed conifer stands were more open than they are today, and typically supported high frequency, low severity fire regimes, and mixed-severity fire was rare. As such, the understory of grass and other non-woody vegetation was more productive and diverse than currently. The predominate tree species were ponderosa pine and Douglas-fir.

**Cool, wet mixed conifer** is found between the warm, dry mixed conifer at the lower elevations and spruce-fir at the higher elevations. This type has only incidental ponderosa pine. Douglas-fir and white fir are the predominant species, but blue spruce may be common, especially in drainages and riparian areas, and aspen may be a major or minor seral component. Fires are infrequent, and fire severity is mixed, with stand replacing crown fire usually occurring in patches (Touchan et al. 1996). Compared to the dry mixed conifer, the composition of these stands has not changed drastically from historic conditions, but, in general, there are more stands in a late seral stage.

As defined in this report, the wet mixed conifer includes a small amount of Engelmann spruce-dominated stands (approximately 450 acres) at the higher elevations. Due to the dominance of Engelmann spruce, these stands are not considered MSO restricted habitat.

**Aspen**
Aspen comprises less than 1 percent of NFS lands in the planning area. It is found in patches associated with disturbance. It is the early seral stage of wet mixed conifer forests; that is, when a fire, landslide, insect outbreak, or other disturbance kills conifer trees, aspen quickly sprouts and grows. Over time, the conifer establishes in the shade of the aspen, and grows to overtop and shade out the aspen. Aspen remains as clumps or individual trees until the next disturbance. Also, if a single tree grows old and dies and creates a gap, aspen will frequently grow in the sunny gap. Some of the aspen groups on NFS lands are young, dating to wildfires in the 1970s. However, most of the aspen is mature or overmature, with a heavy component of conifers succeeding in its place.

The amount of aspen in the planning area has been decreasing, due to drought and the absence of large scale disturbance, until the recent large fires. This is the case across much of the West. In fact, the total acres of aspen in the Southwest is decreasing yearly, as the more shade tolerant mixed conifer species, such as white fir, become established and eventually replace the aspen stands.

Within the wet mixed conifer type, approximately 30% is in the early seral stage dominated by aspen, due to recent fires. Approximately 34% is mid-seral, and 36% is late seral. Therefore, there is not a need to do much treatment in wet mixed conifer at this time.

**Climate**
The climate is the southwest is arid, hot, and variable. It is projected to become warmer, with less precipitation, and more extreme weather events. This could lead to more large fires, insect outbreaks, and more nonnative invasive species. This could have large effects on forests, with increased tree mortality.
In dense forests, trees compete with each other for water, light, and nutrients. In open forests, trees are more vigorous because they have more of these resources, so they can withstand stresses better. Treatments have been designed to reduce competition between trees, while maintaining a forest environment. They will increase forest resiliency against high-severity wildfire, insects, diseases, and extreme weather. The proposed treatments should help perpetuate the forest in the face of climate change. See the Air Specialist report for more information, and a discussion on carbon storage.

The mechanical treatments proposed will require the use of heavy equipment. This will create some emissions. The amount of emissions should be negligible compared with all the other vehicle traffic in the area. See the Air Specialist report for more information. Also, see the Fuels Specialist report for the effects of prescribed fire on climate.

**Habitat Stratification for Mexican Spotted Owl and Northern Goshawk**

This analysis will focus on forest cover types identified in the forest plan (USDA 1987, as amended in 1996) and the new recovery plan for Mexican spotted owl and northern goshawk habitat, namely the ponderosa pine and mixed conifer. There is no pine/oak habitat in the project area. Stratification of these cover types and acres by habitat are displayed in Figures 1, 2 and 3. The number of mixed conifer acres is different because of the way restricted habitat is defined in each recovery plan.

In alternative 1, we are proposing to amend the Forest Plan to cut trees larger than 9” dbh in PACs, in order to reduce the fire danger. Uncharacteristically severe wildfires are the greatest threat to MSO at this time. The purpose of the treatments would be to reduce fuel ladders and encourage medium-size tree to grow faster. The protected steep habitat will not have cutting, except of small trees to create firelines or protect structures. Twenty-five percent of the restricted habitat is to be managed to meet the target/threshold or nest/roost values. Under the old recovery plan, 1,717 acres currently meet these values; an additional 2,792 acres will be managed toward meeting these values. Those acres coincide with old growth. Under the new recovery plan, 3,733 acres currently meet these values; an additional 2,031 acres would be managed toward these values. Those acres coincide with old growth. The remaining seventy-five percent would be managed toward an uneven-age condition.

**Figure 1 MSO habitat stratification and acres, old recovery plan**

<table>
<thead>
<tr>
<th>MSO Habitat</th>
<th>MSO Protected</th>
<th>PAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed Conifer</td>
<td>25,960 acres</td>
<td>7,926 acres</td>
</tr>
<tr>
<td></td>
<td>2,904 acres designated</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Protected Steep- MC &gt;40% slopes</td>
<td>5,022 acres</td>
</tr>
<tr>
<td>MSO Restricted</td>
<td>18,035 acres</td>
<td>Threshold/Target (25% of restricted)</td>
</tr>
<tr>
<td></td>
<td>1,717 acres currently meet condition</td>
<td>2,792 to manage toward threshold condition</td>
</tr>
<tr>
<td></td>
<td>Restricted/Other</td>
<td>13,526 acres</td>
</tr>
</tbody>
</table>
The forested areas that are not classified as MSO habitat will be managed to comply with the forest plan standards and guidelines for NGH. This is a large portion of the project area. Much of the nest and PFA areas are currently even-aged. They will be managed for high canopy cover, with light thinning from below, non-uniform spacing, and small openings, to reduce fire risk. The Foraging Areas are mostly even-aged, and will be managed toward uneven-age structure with group selection. Stands that are currently uneven-aged may be treated to improve the balance of VSS classes, and achieve desired density reductions.

**Stand Density**

According to Long (1985), density management is the manipulation and control of growing stock to achieve specific management objectives. Stand Density Index (SDI) was developed to quantify stands and help guide management. It reflects the number and size of trees growing in a stand; there can be many small trees, or a few large trees, but there is a limit to the amount of biomass a site can support. Percent of maximum SDI gives an indication of how close to that limit a stand is. Keeping a stand at a lower % max SDI maximizes individual tree growth; a relatively higher level maximizes overall stand growth. (Long and Shaw 2005). Stand density index (Reineke 1933) was used to develop guidelines for maintaining stand density within a range where individual tree growth rates would be optimized, and mortality would be reduced. In general, competition begins at 25%, the site is fully occupied around
35%, self-thinning begins at 55% of maximum SDI. Bark beetle mortality can begin around 50-60% (Long and Shaw 2005).

Table 9 displays the existing and desired density by stratum. It displays all acres, not just treatment acres (as Table 16 does). All strata currently exceed 60 percent of maximum SDI, where competition-related mortality and insect activity are considered to be imminent. This correlates with the bark beetle hazard from Table 7, which shows that 89 percent of the ponderosa pine and dry mixed conifer cover types have a high hazard. Desired conditions for stand density are discussed below under Desired Condition.

Table 9. Existing and desired density by stratum.

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Existing Acres*</th>
<th>Existing Condition Average**</th>
<th>Desired Condition Average**</th>
<th>Desired Condition **</th>
<th>Desired Snags per acre</th>
<th>Existing Snags per acre</th>
<th>Desired Snags per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goshawk Nest</td>
<td>617</td>
<td>150</td>
<td>50-245</td>
<td>80-100</td>
<td>69</td>
<td>35-45%</td>
<td>2.7</td>
</tr>
<tr>
<td>PFA</td>
<td>2,412</td>
<td>140</td>
<td>50-245</td>
<td>70-80*</td>
<td>64</td>
<td>25-40%</td>
<td>2.7</td>
</tr>
<tr>
<td>Foraging</td>
<td>40,463</td>
<td>127</td>
<td>5-524</td>
<td>50-70*</td>
<td>60</td>
<td>15-35%</td>
<td>2.7</td>
</tr>
<tr>
<td>MSO Mixed Conifer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAC</td>
<td>2,904</td>
<td>129</td>
<td>42-241</td>
<td>61</td>
<td>40%</td>
<td>5.6</td>
<td>2.5</td>
</tr>
<tr>
<td>Protected-steep</td>
<td>5,022</td>
<td>156</td>
<td>65-244</td>
<td>N/A</td>
<td>72</td>
<td>N/A</td>
<td>5.6</td>
</tr>
<tr>
<td>Restricted Other</td>
<td>16,318</td>
<td>149</td>
<td>34-266</td>
<td>70-90*</td>
<td>71</td>
<td>25-40%</td>
<td>5.6</td>
</tr>
<tr>
<td>Restricted - Target Threshold</td>
<td>1,717</td>
<td>198</td>
<td>155-242</td>
<td>150-170+</td>
<td>91</td>
<td>N/A</td>
<td>5.6</td>
</tr>
</tbody>
</table>

* Not all acres are proposed for treatment. Existing density metric reflect regenerating and other young stands that are not proposed for treatments.
** Within stand matrix (includes interspaces, but does not include regeneration group openings).
*** from Youtz et al. (2012)

Table 9 shows that the basal area and SDI in owl and goshawk habitat are higher than desired; they are so high they indicate the stands could be experiencing mortality, and be vulnerable to beetle attacks. It is necessary to do some thinning to bring them into the desired condition.

**Structure of NGH Habitat**

Northern goshawk standards and guidelines apply to forest communities outside of Mexican spotted owl protected and restricted areas. In the project area, this is primarily ponderosa pine. The objective is to manage for uneven-aged stand conditions throughout NGH habitat, except for the nest stands. However,
the area classified as goshawk habitat is currently 89 percent in an even-aged stand condition (see Figure 2).

The concept of Vegetative Structural Stages (VSS) is used in managing uneven-aged stands for northern goshawk. By creating a balance of size classes, the forest should be able to sustain itself over time. The classes are:

- VSS 1 – opening
- VSS 2 – seedlings/saplings <4.9”
- VSS 3 – poles, 5-11.9”
- VSS 4 – small trees, 12-17.9”
- VSS 5 – large trees, 18-23.9”
- VSS 6 – old trees, > 24”

Three scales were used to examine existing VSS distribution in goshawk forest habitats, as directed by the forest plan: point- or plot-level (fine-scale), stand-level (mid-scale), and landscape-level (EMA forest stratum summary). For the purposes of this analysis, the EMA is considered the SWJM analysis area. Plot-level characteristics are most relevant to analysis of management treatments, because treatments are applied at the fine scale, and the objective is to develop within-stand variability over time. The desired condition is a balanced distribution of VSS within foraging habitat, with an interspersion or mosaic of these structural stages across the stand and landscape. The proportion of VSS classes appears different at different scales because at larger scales, inclusions of VSS 1 and 2 are averaged into larger classes.

As shown in Table 10, the trend is similar at all scales. There is a shortage of VSS 1, 2, 5, and 6. VSS 3 is the dominant VSS, followed by 4.

<table>
<thead>
<tr>
<th>VSS</th>
<th>Desired Condition</th>
<th>Landscape scale for PP/MC</th>
<th>Stand-level for even age Foraging Areas</th>
<th>Plot level for even age Foraging Areas</th>
<th>Plot level for uneven age Foraging Areas</th>
<th>Plot level for PFA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>68</td>
<td>74</td>
<td>53</td>
<td>45</td>
<td>47</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>28</td>
<td>23</td>
<td>35</td>
<td>35</td>
<td>33</td>
</tr>
<tr>
<td>5</td>
<td>20</td>
<td>3</td>
<td>2</td>
<td>8</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>20</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>7</td>
</tr>
</tbody>
</table>

The fine scale (stand exam plot-level) analysis is the most accurate of the three scales. This data indicates that there are groups of larger trees and saplings that can be promoted through uneven-aged stand treatments to move stands and the landscape into a more even balance of sizes and ages.

The mid-scale, or stand-level analysis, classified stands as even-aged or uneven-aged, and assigned a class to even-aged stands. VSS cannot be assigned for uneven-age stands, and since there are relatively few acres of such, their structural stage is not shown. Approximately 74 percent of the foraging area is in
an even-aged condition dominated by VSS 3. This shows the forest is fairly homogenous, with a shortage of regeneration openings, saplings, and large trees.

The large-scale, landscape-level analysis results show the same trend. Most of the area is dominated by VSS 3.

The same trend is evident in goshawk Post-Fledging areas

**Snags**

Data on snags across the project area shows that the current snag population is dominated by the 12 to 18 inch size class (Table 11), which is reflective of the current dominance of small trees in the SWJM analysis area. It is likely that these smaller snags are being created through density-dependent mortality, while the larger snags are being created by bark beetle attacks and root disease. The dbh classes are non-exclusive, so 12 in.+ is all snags greater than 12 inches, 18 in.+ is all snags 18 inches and larger, and 24 in.+ is all snags 24 inches and larger. The general forest plan defines snags as > 10”; forest conditions currently exceed this standard. In the forest plan standards and guidelines for MSO, forest plan old growth standards for snags are to be followed (14” dbh, 1.5 to 2.2/acre). Forest conditions are slightly below this standard. For the goshawk, snags are defined as > 18”, with 2/acre in ponderosa and 3/acre in mixed conifer. The forest is currently below this standard. The data in Table 11 is based on 680 stand exams, with good representation in the ponderosa pine and mixed conifer. There were relatively few exams in the pinyon–juniper.

<table>
<thead>
<tr>
<th>Cover Type</th>
<th>12 in.+</th>
<th>18 in.+</th>
<th>24 in.+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinyon/Juniper</td>
<td>2.0</td>
<td>0.5</td>
<td>0.0</td>
</tr>
<tr>
<td>Ponderosa Pine</td>
<td>2.7</td>
<td>0.8</td>
<td>0.2</td>
</tr>
<tr>
<td>Dry Mixed Conifer</td>
<td>5.6</td>
<td>1.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Wet Mixed Conifer</td>
<td>7.8</td>
<td>1.9</td>
<td>0.7</td>
</tr>
<tr>
<td>Aspen</td>
<td>3.3</td>
<td>0.4</td>
<td>0.3</td>
</tr>
</tbody>
</table>

**Jemez Mountains salamander habitat**

The JMS was listed in September 2013 as an endangered species. Critical habitat was designated in November 2013. There are 12,444 acres of critical habitat within the project area, on the north and east sides. Consultation with Fish and Wildlife Service was completed in July 2015. The designation says, “. . . critical habitat designation does not preclude the proactive treatments necessary to reduce the risk of catastrophic fire or proactively managing forests to restore them to old growth conditions . . .” and “The Service identifies reducing fuels to minimize the risk of severe wildfire in a manner that considers the salamanders’ biological requirements as a special management activity that could ameliorate threats to the species.” (Federal Register 2013). During consultation, it was agreed that the general restoration prescription would be used in critical habitat, using group selection to create an uneven–age stand condition. However, there are timing restrictions to prevent working during wet periods, when salamanders could be near the surface, or soils might be compacted.
Old-Growth Allocation

The forest plan defines old growth as a condition of the forest having structural attributes based on the number of large trees per acre, basal area, canopy cover percent, dead standing trees, and down logs. In this analysis, the EMA is considered the planning area, and cover types identified for developing old growth in the EMA are ponderosa pine and mixed conifer. Old growth standards require allocating at least 20 percent of each cover type, in blocks of 40 acres or more, if possible.

This is how old growth was allocated for this project. In the mixed conifer, 5,172 acres of old growth were needed to meet the 20% allocation. First, stands in MSO PACs and stands that meet the definition for “nest/roost recovery” in the new MSO Recovery Plan were chosen. Where stands went outside the PAC boundary, the additional acres were included. However, if stands only had a few acres in the PAC, they were excluded. Then, some of the wet mixed conifer that has old growth characteristics (according to stand data), that is near JMS stands, especially on the north end of the project area, was added. In choosing stands, thought was given to making large, contiguous blocks, without gaps or “fingers”. Also, stands near private land were not chosen for old growth, because of the fire risk. This added up to 5,171 acres, and is shown on a GIS layer.

In ponderosa pine, 8,718 acres of old growth were needed to meet the 20% allocation. The same process was followed for PACs. There was one occupied JMS stand, and it was added. Then stands which were adjacent to other old growth (not isolated small stands), were added. Stands were added to fill in gaps/fingers, to make more solid, contiguous units. Stands on steep slopes near old growth units were added. Finally, stands on the south and east side of the project area, where there were islands of ponderosa large enough to qualify, were added (the larger blocks were chosen). This gave a total of 8,716 acres, and is shown on the GIS layer. Other cover types were not designated because there are few treatments planned in them.

The forest plan requires old growth to be considered at 3 scales. In this case, the project area is equivalent to an EMA, so it will be the middle scale. On a larger scale, the Jemez Mountains will be used. On a smaller scale, stands will be considered. On the Jemez Mountains scale, old growth is considered and allocated because it is set aside in each large project area. The Cuba district set aside old growth in the forested part of the district. Also, San Pedro Parks Wilderness area, the Jemez Wild and Scenic River corridor, and roadless areas will provide old growth characteristics. Places that are not within projects can be considered to be moving toward old growth, albeit slowly. On a scale smaller than the EMA, the stand level, most large trees will be retained in each stand. This aligns with the desire to have all age classes in each stand, so large, old trees are well-distributed across the landscape. Groups of large trees will be maintained, which will act as a foundation for future old growth. Stands that have been designated to be managed as or toward old growth will have light treatments, maintaining basal areas at the high end of the range, more down wood, and openings at the small end of the range.

 Desired conditions

Reference Conditions

Studying pre-settlement forest structure can help us understand what kind of forest structure is adapted to this area. The pre-settlement forests survived throughout a variety of climates, and give an indication of how many trees the land can support over time, as well as what kind of forest structure is suited to a frequent fire regime, which we are working to restore. Coincidentally, the more open pre-settlement forest may also be well adapted to the warm dry climate we have now; this may be the way to maintain healthy forests with vigorous trees. The project does not try to duplicate pre-settlement conditions, rather, they are used to inform managers about what is sustainable here.
In 2012, the Ecological Restoration Institute did a study of reference conditions in the project area (Sensibaugh et al. 2012). They used stumps and old logs to estimate the tree density prior to 1880. They measured 41 plots, 12 in dry mixed conifer and 29 in ponderosa pine. The range of average number of trees per acre they found is shown in Table 12, below.

**Table 12. Pre-settlement tree densities.**

<table>
<thead>
<tr>
<th></th>
<th>Ponderosa type</th>
<th>Dry mixed conifer type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponderosa</td>
<td>25-41</td>
<td>7-33</td>
</tr>
<tr>
<td>Douglas-fir</td>
<td>0</td>
<td>9-16</td>
</tr>
<tr>
<td>White fir</td>
<td>0</td>
<td>1-9</td>
</tr>
<tr>
<td>Total</td>
<td>25-41</td>
<td>30-50</td>
</tr>
</tbody>
</table>

This was likely a result of a frequent fire regime, supported by a dense grass understory. They determined that the fire regime was interrupted in 1880. They noted that current tree densities are about 200 to 1,000 trees/acre.

A recent paper (GTR-310) summarizes old and new studies on pre-settlement conditions. It shows what basal area, trees/acre, spatial patterns, group size, and more, were like, in the southwest (Reynolds et al 2013). It gives implementation recommendations for restoring forest structure and composition. These will be used, as applicable, in writing prescriptions for the SW Jemez project.

**Pinyon – Juniper**

This vegetation type is a mix of trees and shrubs. Trees occur as individuals or in smaller groups ranging from young to old. Typically, groups are even-aged in structure, with all ages represented across the landscape for an overall uneven-aged grouped appearance. The understory is dominated by low to moderate density shrubs, depending on successional stage. The shrubs consist of turbinella oak, mountain mahogany, sumac, and others, which are well-distributed. Native perennial grasses and annual and perennial forbs are present in the interspaces. Snags and old trees with dead limbs/tops are scattered across the landscape. Large dead wood is present. Fires are typically mixed severity with a moderate frequency (Fire Regime III) with occasional high severity fires (Fire Regime IV). (Region 3 Desired Conditions, 2011)

Although a large portion of the project area is covered with pinyon-juniper, few treatments are planned there. Much of the area is steep, or inaccessible, or is already close to desired condition. There may be some places where treatments would be beneficial and would be implemented.

**Ponderosa Pine**

At the landscape scale, the ponderosa pine forest vegetation community is a composed of trees from structural stages ranging from young to old. Forest appearance is variable but generally uneven-aged and open; occasional areas of even-aged structure are present. The forest arrangement is in individual trees, small clumps, and groups of trees interspersed within variably-sized openings of grass/forbs/shrubs. Openings typically range from 10 percent in more productive sites to 70 percent in the less productive
sites. Size, shape, number of trees per group, and number of groups per area are variable across the landscape. Denser tree conditions exist in some locations such as north facing slopes and canyon bottoms. Fire plays its natural role in the ecosystem.

The forest is composed predominantly of vigorous trees, but declining trees are a component and provide for snags, top-killled, lightning- and fire-scarred trees, and coarse woody debris (>3 inch diameter), all well-distributed throughout the landscape. Ponderosa pine snags are typically 18 inches or greater at DBH and average 1 to 2 snags per acre. Downed logs (>12 inch diameter at mid-point, >8 feet long) average 3 logs per acre within the forested area of the landscape. Coarse woody debris, including downed logs, ranges from 3 to 10 tons per acre. Dwarf mistletoe is present at natural levels, in light infestations, or moderate infestations in small areas.

The composition, structure, and function of vegetative conditions are resilient to the frequency, extent and severity of disturbances and climate variability. The landscape is a functioning ecosystem that contains all its components, processes, and conditions that result from endemic levels of disturbances (e.g. insects, diseases, fire, and wind), including snags, downed logs, and old trees. Grasses, forbs, shrubs, and needle cast (fine fuels), and small trees maintain the natural fire regime. Organic ground cover and herbaceous vegetation provide protection of soil, moisture infiltration, and contribute to plant and animal diversity and to ecosystem function. Frequent, low severity fires (Fire Regime I) are characteristic in this type, including throughout goshawk home ranges. Natural and anthropogenic disturbances are sufficient to maintain desired overall tree density, structure, species composition, coarse woody debris, and nutrient cycling.

At the mid-scale, the ponderosa pine forest vegetation community is characterized by variation in the size and number of tree groups depending on elevation, soil type, aspect, and site productivity. The more biologically productive sites contain more trees per group and more groups per area, resulting in less space between groups. Tree density within forested areas generally ranges from 20 to 80 square foot basal area per acre (including interspaces).

The mosaic of tree groups generally comprises an uneven-aged forest with all age classes present. Infrequently patches of even-aged forest structure are present. Disturbances sustain the overall age and structural distribution. Fires burn primarily on the forest floor and do not spread between tree groups as crown fire.

Forest conditions in goshawk post-fledging family areas (PFAs) are similar to general forest conditions, except these forests contain 10 to 20 percent higher basal area in mid-aged to old tree groups. Goshawk nest areas have forest conditions that are multi-aged but are dominated by large trees with relatively denser canopies than other areas in the ponderosa pine type.

At the fine scale, trees typically occur in irregularly shaped groups and are variably-spaced with some tight clumps. Crowns of trees within the mid-aged to old groups are interlocking or nearly interlocking. Openings surrounding tree groups are variably-shaped and comprised of a grass/forb/shrub mix. Some openings contain individual trees. Trees within groups are of similar or variable ages and may contain species other than ponderosa pine. Size of tree groups typically is less than 1 acre, but averages .5 acres. Groups at the mid-aged to old stages consist of 2 to approximately 40 trees per group. (Region 3 Desired Conditions 2011, Reynolds et al. 2013)

Desired conditions specific to goshawk habitat are described in the forest plan, and are summarized on page 7.

**Dry Mixed Conifer**

At the landscape scale, the dry mixed conifer vegetation community is a mosaic of forest conditions composed of structural stages ranging from young to old trees. Forest appearance is variable, but
generally uneven-aged and open; occasional patches of even-aged structure are present. The forest arrangement is in small clumps and groups of trees interspersed within variably-sized openings of grass/forb/shrub vegetation associations similar to historic patterns. Openings typically range from 10 percent in more productive sites to 50 percent in the less productive sites. Size, shape, number of trees per group, and number of groups per area are variable across the landscape. Where they naturally occur, groups of aspen and oak are present. Denser tree conditions exist in some locations such as north facing slopes and canyon bottoms. Fire plays its natural role in the ecosystem.

The dry mixed conifer forest vegetation community is composed predominantly of vigorous trees, but declining trees are a component and provide for snags, top-killed, lightning- and fire-scarred trees, and coarse woody debris (>3 inch diameter), all well-distributed throughout the landscape. Snags are typically 18 inches or greater at DBH and average 3 per acre. Downed logs (>12 inch diameter at mid-point, >8 feet long) average 3 per acre within the forested area of the landscape. Coarse woody debris, including downed logs, ranges from 5 to 15 tons per acre.

The composition, structure, and function of vegetative conditions are resilient to the frequency, extent, severity of disturbances, and to climate variability. The landscape is a functioning ecosystem that contains all its components, processes, and conditions that result from endemic levels of disturbances (e.g. insects, diseases, fire, and wind), including snags, downed logs, and old trees. Grasses, forbs, shrubs, needle cast (fine fuels), and small trees maintain the natural fire regime. Organic ground cover and herbaceous vegetation provide protection of soil, moisture infiltration, and contribute to plant and animal diversity and to ecosystem function. Frequent, low severity fires (Fire Regime I) are characteristic, including throughout goshawk home ranges. Natural and anthropogenic disturbances are sufficient to maintain desired overall tree density, structure, species composition, coarse woody debris, and nutrient cycling.

At the mid-scale, the dry mixed conifer forest vegetation community is characterized by variation in the size and number of tree groups, depending on elevation, soil type, aspect, and site productivity. The more biologically productive sites contain more trees per group and more groups per area. Openings typically range from 10 percent in more productive sites to 50 percent in the less productive sites. Tree density within forested areas generally ranges from 30 to 125 square foot basal area per acre.

The mosaic of tree groups generally comprises an uneven-aged forest with all age classes and structural stages. Occasionally small patches (generally less than 50 acres) of even-aged forest structure are present. Disturbances sustain the overall age and structural distribution. Fires burn primarily on the forest floor and do not spread between tree groups as crown fire.

At the fine scale, trees typically occur in irregularly shaped groups and are variably-spaced with some tight clumps. Crowns of trees within the mid-aged to old groups are interlocking or nearly interlocking. Openings surrounding tree groups are variably-shaped and comprised of a grass/forb/shrub mix. Some openings contain individual trees or snags. Trees within groups are of similar or variable ages and one or more species. Size of tree groups typically is less than 1 acre. Groups at the mid-age to old stages consist of 2 to approximately 70+ trees per group. (Region 3 Desired Conditions 2011, Reynolds et al 2013).

**MSO Protected Activity Centers:** 100 acre core areas have been identified. Under Alt 1, 3, 4, they may be thinned if there is a clear need to do so. They could have a low-intensity burn. Under Alt 5, they would be avoided. The remaining 500 acres could be treated if it would reduce fire danger and improve habitat quality. Small trees could be removed, and gaps created, while maintaining high basal area and multi-storied canopy. Under alternatives 1, 3 and 4, there would be an 18” dbh cap. Under alternative 5, there would be a 9” dbh cap.

**Mixed Conifer Restricted MSO Habitat (alternative 5):** Twenty-five percent of the mixed conifer forest type (by area) provides MSO target or threshold habitat: basal area >150 ft², twenty 18” + dbh trees per
acre, and 30% of stocking in trees >12” diameter. All trees >24” diameter, substantive amounts of snags >18” diameter, down logs >12” midpoint diameter, and hardwoods are retained following management treatments. Uneven-aged stands are present. The remaining 75% of the acres are managed with a restoration treatment.

**Mixed Conifer Recovery MSO Habitat (alternative 1, 3, 4):** Twenty-five percent of the mixed conifer provides nest/roost recovery habitat: basal area > 120 ft², 12 + 18” or greater dbh trees/acre, > 30% of BA in 12-18” dbh size class, > 30% of BA in 18+” dbh size class. There is a diversity of patch sizes, larger than 2.5 acres, there are openings of .1 to 2.5 acres, and > 60% canopy cover. There are diverse tree, shrub, and herbaceous species. The remaining 75% is managed with a restoration treatment.

**Wet Mixed Conifer**

At the landscape scale, the wet mixed conifer forest vegetation community is a mosaic of structural and seral stages ranging from young trees through old. The landscape arrangement is an assemblage of variably-sized and aged groups and patches of trees and other vegetation associations similar to historic patterns. Tree groups and patches are comprised of variable species composition, depending on forest seral stages. An approximate balance of seral stages is present across the landscape, each seral stage characterized by distinct dominant species composition and biophysical conditions. Canopies are more closed than in dry mixed conifer. An understory consisting of native grass, forbs, and/or shrubs is present.

The wet mixed conifer forest is composed predominantly of vigorous trees, but older declining trees are a component and provide for snags, top-killed, lightning- and fire-scarred trees, and coarse woody debris, all well-distributed throughout the landscape. Number of snags and the amount of downed logs (>12 inch diameter at mid-point, >8 feet long) and coarse woody debris (>3 inch diameter) vary by seral stage.

The composition, structure, and function of vegetative conditions are resilient to the frequency, extent and severity of disturbances and climate variability. The forest landscape is a functioning ecosystem that contains all its components, processes, and conditions that result from endemic levels of disturbances (e.g. insects, diseases, wind, and fire), including snags, downed logs, and old trees. Organic ground cover and herbaceous vegetation provide protection of soil, moisture infiltration, and contribute to plant and animal diversity and to ecosystem function. Mixed severity fire (Fire Regime III) is characteristic. High severity fires (Fire Regime IV & V) rarely occur. Natural and anthropogenic disturbances are sufficient to maintain desired overall tree density, structure, species composition, coarse woody debris, and nutrient cycling.

At the mid-scale, the size and number of groups and patches vary depending on disturbance, elevation, soil type, aspect, and site productivity. Patch sizes vary but are frequently in the hundreds of acres, with rare disturbances in the thousands of acres. Groups and patches of tens of acres or less are relatively common. A mosaic of groups and patches of trees, primarily even-aged, and variable in size, species composition, and age is present. Openings created by disturbance may comprise 10 to 100 percent of the mid-scale area, depending on the time since disturbance. Aspen is occasionally present in large patches.

Density ranges from 20 to 180 basal area, depending upon time since disturbance, and seral stages. Snags 18 inches or greater dbh range from 1 to 5 snags per acre, with the lower range associated with early seral stages, and the upper range associated with late seral stages. Snag density in general (>8 inches DBH) averages 20 per acre. Coarse woody debris, including downed logs, varies by seral stage, with averages ranging from 5 to 20 tons per acre for early-seral stages; 20 to 40 tons per acre for mid-seral stages; and 35 tons per acre or greater for late-seral stages.

Mixed (Fire Regime III), and occasionally high (Fire Regime IV) severity fires, and other disturbances, maintain desired overall tree density, structure, species composition, coarse woody debris, and nutrient cycling. High severity fires generally do not exceed 1000 acre patches of mortality. Other smaller disturbances occur more frequently.
Forest conditions in goshawk post-fledging family areas (PFAs) are similar to general forest conditions, except these forests contain 10 to 20 percent higher tree density (basal area) than goshawk foraging areas and the general forest. Nest areas have forest conditions that are multi-aged but are dominated by large trees with relatively denser canopies than other areas in the wet mixed conifer type.

At the fine scale, in mid-aged and older forests, trees are typically variably-spaced with crowns interlocking (grouped and clumped trees) or nearly interlocking. Trees within groups can be of similar or variable species and ages. Small openings (gaps) are present as a result of disturbances.

Few treatments are anticipated in wet mixed conifer, because these stands have long disturbance intervals, and the seral stages are fairly well balanced. Possible reasons for treatment are: proximity to endangered species habitat, WUI, springs, insects, disease, or other special need areas, or as small inclusions of wet mixed conifer within other cover types. Treatments would be uneven aged, individual tree selection across size classes with small (0.1 acre) openings for regeneration, possibly some light thinning, if needed, to reduce fire hazard. We would try to balance successional stages. If early succession (aspen) is lacking (less than 20% of the cover type), we would cut patches to stimulate regeneration. Stands would be burned only if fire backs into the stand from an adjacent stand.

Aspen
One of the project goals is to keep aspen present and viable on the landscape. Aspen is desirable for wildlife habitat and scenic beauty. It can moderate fire behavior, improve soils, and provide diversity. It can decrease due to disease (Sudden Aspen Death, tent caterpillars, etc.), drought, and being overtopped by conifers. However, it is stimulated by fire and other disturbances. Recent research indicates that aspen can fill different roles in different situations (Long and Mock 2012, Paul Rogers, pers. comm. 2013). It can come in as an early seral species after fire, in a pure stand, and gradually give way to conifers. In this case, the stand size would be related to the size of the fire. However, in mixed conifer, aspen can exist as a few stems in a small opening, and persist for many years. Recent research also shows that reproduction by seeds is more common than previously believed, so it is less critical to maintain clones, since new aspen can be germinated in new locations by seeds (Long and Mock 2012).

In the SW Jemez project area, patches of aspen were probably relatively small, as a result of small fires, and were scattered across the landscape based on aspect and disturbance, and moved over time. Aspen are also commonly found in valley bottoms where they benefit from the extra water. Currently, there is a lot of aspen on the east side of the project area where the Las Conchas fire burned, and small patches in other areas. We want to keep patches well-distributed across the landscape.

Currently, the seral stages of wet mixed conifer are roughly balanced, with about 1/3 each in early, mid, and late seral stages. Therefore, the project just needs to maintain this balance.

Old Growth
According to the Forest Plan, 20% of each cover type should be in old growth, as defined in the Plan. Some stands already meet those criteria; others are close, and can be managed to meet the criteria more quickly. Stands have been allocated, as described earlier, and some may be managed to meet old growth criteria as quickly as possible.

Snags
There will be at least one or 2.5-3 snags/acre (depending on cover type), as required by the forest plan (see Table 1). There are already some snags present (see Table 1). The data doesn’t exactly correspond to the forest plan standards. By extrapolation, it appears that there are close to the desired number of snags. If a particular area is short on snags, more could be created with prescribed fire. A technique for
creating snags by girdling trees has been tried across the southwest, but it doesn’t work well – the new
snags quickly break off. Fire seems to be a better method of creating snags. Like live trees, snag
“populations” are constantly changing, as some fall over, and others are recruited through fire, old age,
drought, insects, and disease.

Description of Alternatives
Refer to Chapter 2 of the EIS for a full description; this section is specific to forestry actions. Cutting
would occur where practicable to achieve restoration goals. Under alternative 1, 3, and 4, the Forest Plan
would be amended to allow us to follow the new MSO Recovery Plan. Under alternative 5, the current
Forest Plan, with the old recovery plan guidelines, would be followed. This difference would apply in
PACs and target/threshold or nest/roost habitat. In the rest of the restricted or recovery habitat, the same
uneven age, restoration prescription would be used. In the rest of the project area, treatments would be
the same across alternatives. In the ponderosa pine cover type, standards and guidelines for the northern
goshawk, from the Forest Plan, would be followed. Even-age stands would be treated to become uneven-
aged over time. Uneven age stands would be maintained and moved toward a balance of structural
stages. This means balancing the VSS classes as much as possible at the stand scale, by creating mosaics
of different aged groups of trees, and interspaces between groups. There would be no cutting on slopes
over 40%, except as needed for fuels projects.

Some meadows, springs, and seeps have been colonized by trees, and need to be opened up, to restore this
limited but productive habitat. Some meadows are identified by the Terrestrial Ecosystem Survey.
However, it is too coarse to identify all areas that should be meadows; these will be identified with the
soil scientist as the units are treated. Old growth has been allocated and mapped. Aspen stands will be
maintained in small patches scattered across the landscape, to keep aspen present and vigorous. This will
be done by cutting competing conifers, or cutting aspen to stimulate sprouting. Alternatives 1, 3, and 5
would use fire to reduce the slash after mechanical treatments. They would also have fire on most of the
project area outside mechanical treatments. Alternative 4 would only have fire outside the mechanical
treatments, so about 30,000 fewer acres would be burned.

Areas for treatment have been roughly identified by GIS mapping. However, a computer exercise can
never be completely accurate. Boundaries may need to be changed when units are laid out in the field.
Places that don’t need work or that have constraints will be dropped. Additional areas may be added if
they meet the parameters for restoration. The proper design criteria would be applied, based on the
condition of the stand. The general prescriptions and design criteria are described below.

MSO PAC (Alt. 1, 3, 4)
Evaluate the 5 PACs on an individual basis. Base treatments on local topography, to reduce fire danger
and improve habitat quality. There could be cutting in core areas if it would clearly benefit the habitat.
There could be low-intensity burns as well. In the remaining 500 acres, where possible, reduce ladder
fuels and continuity; in dense patches of forest, thin small and medium size trees, while leaving multiple
stories and high canopy cover. The minimum patch size is 2.5 acres, and the maximum opening should be
less than 2.5 acres. Ideally, over half the basal area would be in trees > 16” dbh. There would be good
diversity of tree species, and interlocking crowns. Use individual tree selection or free-thinning cutting
methods. Cut trees less than 18” dbh as needed to improve habitat. It is expected that only about 15% of
the PAC area would be treated. Refer to Revised Recovery Plan tables C.1 and C.2.
MSO PAC (Alt. 5)

Evaluate the 5 PACs on an individual basis. Base treatments on local topography, to reduce fire danger and improve habitat quality. Core areas would not be treated; fireline would be built to keep prescribed fire out of the cores. In the remaining 500 acres, where possible, reduce ladder fuels and continuity; in dense patches of forest, thin small and medium size trees, while leaving multiple stories and high canopy cover. Use individual tree selection or free-thinning cutting methods. Cut trees less than 9” dbh as needed to improve habitat. It is expected that only about 15% of the PAC area would be treated. Refer to Forest Plan App. D.

MSO Recovery Nest/Roost (Alt 1, 3, 4)

Stands that are denser than the target level may be thinned if it would help reduce fire danger or grow larger trees faster. Treatments will not take the stands below the desired basal area of 120. Keep canopy cover > 60%. Stands that are below target level may be thinned to increase tree growth rate, reduce fire danger, and keep the stand on the desired trajectory toward large trees. Use individual tree selection and free thinning to create a multi-storied, uneven age stand with occasional openings. Refer to 2012 Recovery plan tables C.1, C.2 and C.3.

MSO Target/Threshold (Alt. 5)

Stands that are denser than the target level may be thinned if it would help reduce fire danger or grow larger trees faster. Treatments will not take the stands below the desired basal area (150/170) and tree sizes. %. Stands that are below target level may be thinned to increase tree growth rate, reduce fire danger, and keep the stand on the desired trajectory toward large trees. Use individual tree selection or free thinning to create a multi-storied, uneven age stand with occasional canopy gaps. Refer to the Forest Plan App. D

MSO protected (Alt. 5)

Use thinning from below with a 9” dbh cap as needed for fire breaks and WUI protection.

MSO Restricted or Recovery (75% of mixed conifer) (Alt. 1, 3, 4, 5)

See prescription for mixed conifer. No trees > 24” dbh would be cut.

The following Design Criteria apply to all action alternatives.

NGH Nest Areas

Move stands toward a dominance of VSS 5 and 6. Keep multiple ages and high canopy cover (50-70%) and non-uniform spacing. Use individual tree selection and free thinning

NGH PFA

Same VSS structure as foraging area, but with 10-20% higher basal area, smaller openings and higher canopy cover. Use individual or group tree selection and free thinning.

NGH Foraging Area (Ponderosa Pine)

Use group selection, in accord with forest plan, and guided by Regional Desired Conditions.

1. A target basal area 50-70 within groups of trees or about 20-70 overall (including interspaces).

2. Leave tree groups are 0.1 to 4 acres, generally ranging from .1 to .5 acres, and generally consist of 2 to 14 dominant and co-dominant trees per .1 acre.
3. Approximately 10% of the area would be in openings (grasses and forbs), and approximately another 10% in regeneration openings (seedlings and saplings). Therefore, a total of up to 60% of the area would be in openings and interspaces between groups.

4. Crown spacing between groups of trees (interspace) would vary depending on treatment intensity. Interspaces would usually be 30-60 feet between groups of trees, but could be as much as 100 feet. A total of 10-70% of the area would not be treed because of openings and interspaces. There would be more interspace where the site quality is lower.

5. Openings are up to 4 acres in size and placed in VSS 3 and 4 stands, or areas with heavy mistletoe, or around existing openings.

6. VSS classes would be balanced as much as possible.

7. Species composition would be primarily ponderosa pine, with some Gambel oak and juniper. Douglas-fir and limber pine are incidental.

8. Leave 5-7 tons per acre of woody debris and 2 snags per acre and 3 down logs/acre

9. Prescribe burn every 5-10 years.

There are some young, even age stands that were planted or had natural regeneration after large fires. They are overstocked and will be treated according to the following Design Features:

1. Thin, primarily from below, to improve growth and vigor.

2. Establish interspaces of 30-60 feet between tree groups.

3. Create openings on 10% of the area. Release any existing saplings on an additional 10% of the area. The priority for establishing openings would be in currently non-stocked areas and in areas that have moderate to severe dwarf mistletoe infection.

4. Prescribe burn to treat slash

**Dry mixed conifer**

Use group selection in accord with the Forest Plan and regional desired conditions:

1. Target basal area of 30-100 overall, and 60-80 within groups.

2. Groups are .1 to 2.5 acres, averaging less than 1 acre. 10% of the area would be in openings, another 10% in regeneration. A total of 10-50% of the area would not be treed because of openings and interspaces. Interspaces are 30-60 feet between groups of trees.

3. VSS classes would be balanced as much as possible.


5. Leave aspen as individual trees or small groups.

6. Leave 10-15 tons per acre of down logs greater than 12-inches diameter and 3 snags per acre, on average. Leave 5 down logs/acre.

7. Prescribe burn every 7-12 years.

8.
The following Design Features would apply in young, even–age stands:

1. Treatments are similar to those described above for young, even-age ponderosa pine stand improvement.

2. Create groups and openings, but smaller than in ponderosa. Leave higher stand density than in ponderosa pine.

3. Prescribe burn to reduce slash.

**Wet mixed conifer**

Few treatments would be done in this type. Reasons to treat would include WUI, fire lines, or if a deficit of early successional stages becomes apparent. Individual tree selection would be used.

If it appears that there is a shortage of aspen in a part of the project area, the following actions may be taken:

1. Cut invading conifers in stands. Cut trees may be removed.

2. To rejuvenate old stands of aspen, stimulate regeneration by cutting conifers where they have overtopped aspen stands. It may be necessary to cut some mature aspen to stimulate sprouting.

3. Focus on releasing aspen stands on the north and west portions of the project area, because the eastern portion is near the Las Conchas burn which has lots of young aspen.

4. Create patches of 1-10 acres, spread across the landscape, to provide vegetative diversity and fire breaks.

5. Locate patches in existing conifer stands of VSS 3 and 4, because they are in excess. Focus patches on places where conifers have mistletoe, budworm, high bark beetle risk, etc., and where aspen is already present.

**Allocated old growth**

Stands to be managed toward old growth have been identified. They will be examined to see if treatments can accelerate their growth toward meeting the standards. Some Design Features that will be used to help create old growth are:

1. Use free thinning, targeting primarily small trees. Create gaps in the overstory; release medium and large trees to grow faster.

2. Burn slash from mechanical treatments, but avoid reducing the amount of large woody debris.

**Stands with heavy dwarf mistletoe**

These treatments would occur on less than 7% of the forested area; site specific evaluation would be done to develop a prescription. Generally, we would cut infected ponderosa pines, and leave other tree species.

**Pinyon-Juniper**

Only a small portion of the Pinyon–juniper type will be treated. In these cases, the following Design Features would be used:

1. Desired residual tree densities are between 50-200 trees per acre.

2. Leave a range of tree sizes.
3. Prioritize areas for treatment to reduce erosion, protect heritage sites, or to increase habitat for songbirds.

4. Firewood may be gathered where roads allow.

5. Scatter slash to provide ground cover.

6. No broadcast burning.

The above numbers for basal area and spacing are based on Region 3 desired conditions (2011) and sample prescriptions. Actual numbers will depend on the site quality and current structure.

**Jemez Mountain Salamander**

In critical habitat, treatments would follow the restoration prescription. Prescribed fire would be used. Equipment would not work when the soil is wet.

**Meadows**

Cut conifers < 24” dbh in meadows. Leave a few trees that are stabilizing streambanks. Trees may be removed or left for channel stabilization and down wood. Meadows can be identified by topography, relic plants, current grasses and forbs, and soil characteristics. The Terrestrial Ecosystem Survey is not detailed enough to identify meadows.

**Springs and seeps**

Work with the hydrologist to determine which trees to remove. If riparian species are present, remove invading conifers to release riparian, deciduous species. Keep trees that are stabilizing the soil.

**Other considerations**

Mitigation will be needed to help prevent an outbreak of bark beetles in cut areas. In general, slash greater than 4 inches diameter that is created between January 1 and June 30 must be removed, burned, cut to short lengths, or otherwise treated, within 30 days. Material cut in winter may be left on site until March 15, when it must be disposed of. Chipping should not occur in spring, as it releases chemicals which attract beetles (AZ Coop Ext. 2008). These measures may be modified by a silviculturist based on monitoring of beetle populations, weather, and specific stand conditions.

In the past, the Jemez Mountains have had abundant tree regeneration. After fires or logging, ponderosa pine and Douglas-fir has seeded in. In established forests, Douglas-fir and white fir have seeded in. Two-three wet years are needed for ponderosa to germinate as seedlings, and more good rain years are needed to help them grow into trees. While every year is not a good seed year, there have been enough good seed years to sustain the forest. This natural regeneration can no longer be taken for granted, due to climate change. With the predicted warmer, drier climate, it will be harder for seedlings to germinate and establish and grow into trees. Therefore, it is important to keep some of the current seedlings, saplings, and poles, and thin them to a proper spacing to allow them to thrive. Overstory trees may need to be removed to release the small trees. It may be a long time before there is more natural regeneration.

**Indicators**

In relation to forest vegetation, we identified two main measures:

- Restore spatial pattern, processes, resiliency, structure, and species composition by creating generally open, uneven-aged forests in ponderosa pine and dry mixed conifer types.
• Indicators: Forest stand conditions – basal area, trees per acre, acres treated, change in proportion of VSS classes

• Offset treatment costs and provide economic opportunity.
  • Indicators: Volume of merchantable sawlogs (ccf), firewood (cords), biomass (tons), and other forest products generated.

Environmental Consequences

Effects

Alternative 1 – Proposed Action (Revised MSO Recovery Plan)

Forests would be selectively cut to manage toward a condition that is healthy and sustainable over time, more resistant to uncharacteristically severe wildfires and climate change. Forests would have all ages of trees, so that as older trees die, there are younger ones to take their place, and new trees regenerating. There would be groups of trees, with interlocking crowns. There would be spaces between the groups, so trees don’t have to compete for water and nutrients, and they can grow to a larger size faster. The spaces also facilitate surface fires rather than crown fires, provide space for forbs, grasses, and shrubs to grow. Management would emphasize retaining VSS classes that are deficient, such as 2, 5, and 6, and reducing VSS classes that are overabundant, such as 3 and 4. VSS classes would be better balanced than they are now, and maintain that balance over time.

For the most part, slash would be lopped and scattered, then burned. Slash could also be piled and burned. It is also possible that trees would be whole-tree yarded, and slash handled at the landing. Any method used would keep down wood at a natural level, and stimulate grass growth. Oaks would be free to grow to larger sizes and produce acorns. Openings would be created for new seedlings to grow in (since ponderosa needs full sun to sprout). There would be abundant grass and forbs.

Stands would be more resistant to uncharacteristically severe wildfires, because of the space between groups and reduction in ladder fuels. Prescribed fires would reduce down wood/fuels, helping to prevent severe fires. Fires would generally burn on the ground and be cool. Fires may kill a few trees, thinning within groups, and creating small openings. Most large trees would be able to survive these fires; most mortality would be in saplings. Fire would clear litter off the soil, creating spots for pine regeneration.

Stands would also be more resistant to large insect outbreaks, because the trees would be vigorous and able to fend off insect attacks. Mistletoe would be at more natural levels; the space between groups would reduce the rate of spread, and the prescribed fires would help reduce infestations (Conklin and Fairweather 2010).

The landscape would be heterogeneous, with varying tree densities and sizes. There would be intermingled patches of different seral stages and ages. North-facing slopes would have denser forests than south facing slopes.

Aspen stands would be of various sizes, and scattered across the landscape. Over time, they may move around the landscape. The abundance of aspen would create more overall diversity.

Old growth structural stages would be achieved faster, by thinning to free trees to grow to larger sizes, and by creating multi-storied stands.
The mechanical treatments would create jobs working in the woods, in mills, and related work. Products such as mulch, pellets, fencing, firewood, vigas, lumber, and more would be created for people to use. Then these products would not have to be imported over long distances.

Apx. 54,000 acres would be treated over a period of 10-15 years. Of this, about 30,000 acres would have harvest of commercial wood products. Other stands would not be treated, which would add to the overall diversity.

In MSO core areas, light burning would occur, which would reduce risk from wildfires. In about 410 acres of PACs (out of 2,904 acres total), thinning to a basal area of 120, with an 18” cap, could be done, if it would improve habitat quality and reduce fire risk. Nest/roost recovery habitat (about 1,670 acres out of 5,764 total) could be treated the same way. The restoration prescription brings the treated stands to 24% of max SDI, giving trees room to grow vigorously. This prescription grows the biggest trees in 20 years (16.4”).

Currently, the age structure of stands (VSS classes) is out of balance. Treatments would bring the distribution of classes closer to the desired condition shown in Table 14. Table 14 shows that the forest is currently unbalanced, with too many even-aged stands dominated by VSS 3 and 4, while VSS 1, 2, 5 and 6 are lacking. While there actually are some VSS 1 and 2 patches currently, they are lost in this stand-level analysis – the small areas are included in the other VSS classes. The table also shows that the treatments would move the forest more into balance; there would still be too many stands in VSS 4, but VSS 3 would be close to the objective, and VSS 5 and 6 would be closer. VSS 1 openings would be created, and VSS 2 could be created by removing overstory from existing sapling groups. Over time, more trees would recruit into the larger classes.

Table 13. Changes in percentages of VSS Classes with Proposed Treatment (stand level).

<table>
<thead>
<tr>
<th>VSS</th>
<th>All foraging area</th>
<th>Even-age foraging</th>
<th>Uneven-age foraging</th>
<th>PFA</th>
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<td>Existing</td>
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<td>Existing</td>
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Stand Density Index is based on tree size and number. It is an indicator of how much biomass is on the site, relative to what the site can support. Stands in the very high class (> 55%) are overstocked, so trees will be dying due to competition for light and moisture. Stands in the high class (35-55%) have slowing growth and are beginning to be stressed. Stands in the moderate class (25-34%) are growing well and have some understory. This is often the density we manage for, giving the best individual tree and total stand growth, and tree health. Low (0-24%) is understocked, creating room for new trees to germinate, and for existing trees to grow quickly. It is desired to have a portion of the forest in this class, to perpetuate the forest over time. Currently, most stands are overstocked (Table 14). Table 15 shows numbers for alternatives 4 and 5. The numbers for alternatives 1 and 3 would be very similar.

Treatments would move stands to a lower stocking level, which would reduce tree stress, increase growth rate, and create space for the next cohort to establish.
Table 14. Changes in Density Class with Treatment.

<table>
<thead>
<tr>
<th>Habitat Strata</th>
<th>Stand Density Class (as % of max SDI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>very high</td>
</tr>
<tr>
<td>MSO PAC existing</td>
<td>75%</td>
</tr>
<tr>
<td>MSO PAC after treatment</td>
<td>24%</td>
</tr>
<tr>
<td>MSO restricted existing</td>
<td>61%</td>
</tr>
<tr>
<td>MSO restricted after treatment</td>
<td>3%</td>
</tr>
<tr>
<td>MSO protected existing</td>
<td>78%</td>
</tr>
<tr>
<td>MSO protected after treatment</td>
<td>5%</td>
</tr>
<tr>
<td>NGH nest existing</td>
<td>41%</td>
</tr>
<tr>
<td>NGH nest after treatment</td>
<td>0%</td>
</tr>
<tr>
<td>NGH foraging existing</td>
<td>73%</td>
</tr>
<tr>
<td>NGH foraging after treatment</td>
<td>7%</td>
</tr>
<tr>
<td>NGH PFA existing</td>
<td>74%</td>
</tr>
<tr>
<td>NGH PFA after treatment</td>
<td>0%</td>
</tr>
</tbody>
</table>

Because there is a concern about removing large trees, we calculated the percentage of trees removed in the larger dbh classes. The 16-24” class was used (rather than 18-24”) because 16” has been used in many publications, and is of interest to some publics. We estimate that 10% of the trees larger than 16” would be removed to create openings and group structure. This is probably an over-estimate, because it doesn’t account for prescriptions to favor large trees in old growth, restricted, protected, and recovery habitat.

Table 15 displays current stand conditions, as measured by basal area (BA), % of maximum Stand Density Index, trees per acre (TPA) and Quadratic Mean Diameter (QMD). The number of acres shown to be treated is approximate, and could be lower or higher, depending on conditions on the ground. The table shows conditions right after treatment, and 20 years after treatment. The treatment modeled was cutting, piling and burning slash, then doing a broadcast burn a year later. The model indicated that burning at these relatively high densities causes some additional mortality; this is why the post-treatment numbers are low. These models show the relative differences between treatments, but not exactly what would happen in actual implementation. They can be used to inform the prescriptions, and achieve the desired density.

Basal area is greatly reduced by treatments, since that is the goal, and increases again over the 20 years as trees grow. MSO PACs are currently at an average basal area of 135; it might seem that there is no need to thin them if the target BA is 150/170. However the 135 is an average; some are much higher; stands
that are already low may not be thinned. Also, the 150/170 target applies only to target/threshold habitat, not to PACs. One goal of this project is to reduce the fire danger in PACs in order to preserve the owls’ habitat. Another reason that the post treatment numbers appear low is an artifact of the modeling: dense points are thinned, but some points are below the desired BA; these are averaged with thinned patches, which reduces the average below the target. In actual implementation, there would be flexibility in thinning to the desired level.

SDI is also greatly reduced, achieving target levels in MSO habitat. It appears to be too low in NGH nest and PFAs, for the same reason as described above. SDI increases over the 20 year projection, as the trees grow larger. The number of trees per acre is greatly reduced, then stays steady or drops over the next 20 years, due to prescribed burns that control the numbers of seedlings.

The ponderosa pine and dry mixed conifer ecosystem evolved with fire, and need periodic fires to stay healthy. Most of the project area outside the mechanical treatment units would have prescribed burns. The benefits are fire are many: thinning of trees, creation of gaps and openings, nutrient cycling, seedbed creation for grasses and trees, rejuvenation of grasses, and fuel reduction which helps prevent hot wildfires. See the Fuels report for more information.
Table 15. Changes in Stand Metrics after treatment and 20 years after treatment

<table>
<thead>
<tr>
<th>Habitat Strata</th>
<th>Treatment Acres</th>
<th>BA-Pre</th>
<th>BA-Post t</th>
<th>BA-20 years</th>
<th>%Max-SDI-Pre</th>
<th>%Max-SDI-Post</th>
<th>%Max-SDI-20 years</th>
<th>TPA-Pre</th>
<th>TPA-Post</th>
<th>TPA-20 years</th>
<th>QMD Pre</th>
<th>QMD Post</th>
<th>QMD 20 years</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alternative 1 (new recovery plan)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSO PAC</td>
<td>410</td>
<td>135</td>
<td>92</td>
<td>108</td>
<td>63%</td>
<td>36%</td>
<td>40%</td>
<td>634</td>
<td>155</td>
<td>139</td>
<td>7.0</td>
<td>10.9</td>
<td>12.3</td>
</tr>
<tr>
<td>MSO nest/roost</td>
<td>1,680</td>
<td>178</td>
<td>104</td>
<td>126</td>
<td>85%</td>
<td>36%</td>
<td>42%</td>
<td>1,893</td>
<td>301</td>
<td>288</td>
<td>4.6</td>
<td>11.0</td>
<td>12.3</td>
</tr>
<tr>
<td><strong>Alternative 5 (old recovery plan)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSO PAC</td>
<td>410</td>
<td>135</td>
<td>105</td>
<td>121</td>
<td>63%</td>
<td>42%</td>
<td>47%</td>
<td>634</td>
<td>224</td>
<td>205</td>
<td>7.0</td>
<td>9.7</td>
<td>10.9</td>
</tr>
<tr>
<td>MSO target/ threshold</td>
<td>360</td>
<td>192</td>
<td>128</td>
<td>153</td>
<td>96%</td>
<td>47%</td>
<td>55%</td>
<td>1,856</td>
<td>256</td>
<td>245</td>
<td>5.3</td>
<td>10.6</td>
<td>12.0</td>
</tr>
<tr>
<td>MSO protected</td>
<td>30</td>
<td>163</td>
<td>71</td>
<td>88</td>
<td>80%</td>
<td>25%</td>
<td>29%</td>
<td>1,166</td>
<td>77</td>
<td>73</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Both</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSO Restricted-other Recovery</td>
<td>6,730</td>
<td>172</td>
<td>81</td>
<td>96</td>
<td>81%</td>
<td>24%</td>
<td>28%</td>
<td>1,788</td>
<td>77</td>
<td>75</td>
<td>4.6</td>
<td>14.7</td>
<td>16.4</td>
</tr>
<tr>
<td>MSO Critical Habitat*</td>
<td>12,450</td>
<td>139</td>
<td>62</td>
<td>79</td>
<td>65%</td>
<td>23%</td>
<td>28%</td>
<td>582</td>
<td>76</td>
<td>70</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NGH nest</td>
<td>330</td>
<td>163</td>
<td>71</td>
<td>87</td>
<td>74%</td>
<td>24%</td>
<td>29%</td>
<td>561</td>
<td>59</td>
<td>56</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NGH PFA</td>
<td>1,220</td>
<td>153</td>
<td>66</td>
<td>83</td>
<td>71%</td>
<td>23%</td>
<td>28%</td>
<td>601</td>
<td>62</td>
<td>58</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NGH foraging area</td>
<td>20,940</td>
<td>143</td>
<td>58</td>
<td>75</td>
<td>67%</td>
<td>21%</td>
<td>25%</td>
<td>612</td>
<td>62</td>
<td>58</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: MSO critical habitat overlaps other habitat strata – treatment acres are a subset of total treatment.
Alternative 2 – No Action

No stand improvement thinning or restoration cutting would occur (except in a few areas with previous NEPA decisions). The trees would continue to grow. Many stands are already at maximum carrying capacity, so trees there would continue to die, as the stands self-thin. This would create fire ladders and high fire hazard. Stands that are below capacity would grow until they reach maximum capacity; since there are too many trees, trees would be small and growth would stagnate; they would not grow to their potential. Spacing would be dense and fairly uniform. VSS 5 and 6 trees would grow slowly. There would be an overabundance of VSS 3 and 4 classes, a shortage of VSS 2 saplings, and a shortage of VSS 1 openings.

Oaks would be suppressed, short and shrubby. They would not be able to attain their tree form, and produce abundant acorns. There would be little regeneration of new trees, since the canopy would be closed. Meadows and openings would close in. New openings would not be created. There would be fewer shrubs, and much less grass and forbs; the forest floor would consist of pine needles. Dead wood and needles would accumulate.

Stands would be susceptible to uncharacteristically severe wildfires, since the canopies are mostly continuous and there are lots of ladder fuels. Any fires that started would kill most of the trees over a large area. It would take decades for the forest to re-establish, if it did at all. The benefits of prescribed fire would not be realized.

The stands would also harbor increasing amounts of mistletoe, since it spreads from canopy to canopy. Spread is characteristically limited by surface fires and irregular tree distribution. Without the effects of prescribed fire, more trees would be stunted and deformed by mistletoe. The stands would also be susceptible to insect outbreaks, particularly bark beetles. Since the trees are dense and stressed, they would be less able to ward off an attack, and many acres could be lost.

The landscape would become more homogenous, as stands move toward late successional stages, with fewer early and mid-successional stands. The canopy would be fairly continuous and closed. Tree distribution would be fairly uniform. Diversity would decrease over time. It would take a long time for trees to grow to a large size, and many never would.

Aspen stands would be overtopped by conifers, and die out, decreasing forest diversity. There would be little regeneration of new or young aspen, unless a fire occurred.

Existing old growth stands would remain fairly stable, with trees growing slowly. Additional old growth would accrue only slowly, since trees are repressed. Stands would be vulnerable to uncharacteristically severe wildfires since they are full of ladder fuels. We would not be able to manage stands toward creating more old growth.

There would be no new economic opportunities, and no products generated.

Alternative 3 – no construction of temporary roads

Apx. 1,900 fewer acres would be mechanically treated than in Alt. 1. The effects on treated stands would be the same. On the 1900 acres, the effects from burning would be as described in the proposed action.

Alternative 4 – less prescribed fire

The forest structure would be as described in the proposed action, with groups and spaces, and all sizes of trees. However, the slash treatment would be different and have different effects. Some of the large wood could be hauled out as product and firewood. The remaining wood, perhaps 4” and less, would
remain on site. If not disposed of, it would create a fire hazard. If prescribed burning is not allowed, it
would have to be chipped/masticated/shredded. The effects of mastication are just beginning to be
studied.

In a large, nation-wide study, McIver et al. (2012) found that mechanical treatments alone did change the
stand structure and reduce fire hazard, but did not have the other ecological effects of fire, such as
creating patchiness, abundant understory, and animal species richness. He says, “Individual fires have
unique characteristics and effects because of temporal and spatial variation, however, suggesting that
mechanical treatments are not surrogates for many ecological variables, and repeated application
of mechanical treatments without fire would likely result in conditions divergent from those occurring in
fire-adapted systems where fire is a common disturbance event.” Pg. 29.

Another study found that if masticated material was burned when the soil was moist, there were few
effects on the soil. However, some of the residual trees died from scorch. If a fire burned when the soil
was dry, there was severe soil damage (Fire Science Brief 2009).

In a study in the Sierra Nevada in a 25 year old ponderosa plantation, mastication did reduce flame length,
rate of spread, and torching; it reduced the risk of crown fire, but increased surface fire behavior and
resistance to control. Burning the masticated material killed about half of the residual trees. (Reiner,
Vaillant, and Dailey 2012).

Personnel on the Santa Fe National forest have experience with the effects of mastication. If a wildfire
does burn through a masticated area, if the slash is more than 1” deep, the effects can be more severe than
if the slash had been treated conventionally. Mastication will not prevent fires from burning through, and
in some situations can create a hotter fire. (Armstrong, personal communication.). See the fuels
specialist report for more information.

While results are not all consistent, overall it appears that mastication can reduce the fire danger by
putting all the woody material on the ground, reducing fuel ladders. However, if there is a great quantity
of material (branches, twigs, needles), and we expect there would be, it can create a deep fuel bed. If the
chips burn when the soil is dry, they will hold heat for a long time, heating and sterilizing the soil, and
killing some of the remaining trees by overheating their roots. The mulch that is created will protect the
soil, and will decompose over time, which is good for the soil. However, while it is breaking down, it
will tie up soil nutrients/nitrogen which won’t be available to the plants. Also, a deep bed of chips can
suppress grass growth. The understory will be depauperate, seed beds for new trees will not be created,
mistletoe will not be held in check, and various sizes of down wood will not be present. The stands will
not be as fire-resistant as in the proposed action. For more information on the effects of slash treatment
and mastication, see the Fuels Specialist Report.

The benefits of fire will be realized outside the mechanical treatments.

There would be fewer acres of aspen regeneration. Aspen stands in the burn areas would be stimulated
and maintained. However, aspen would have a hard time sprouting in the treated areas because of the
thick chips.

Old growth could be enhanced by light thinning in appropriate stands. However, stands would remain
susceptible to uncharacteristically severe wildfires, since they would be outside the normal fire regime,
and have ladder fuels and low branches. Burning in untreated stands could enhance old growth if the
conditions were just right; this would require a narrow window of conditions and be difficult to achieve.
**Alternative 5 – use standards and guidelines in Forest Plan for treatments in MSO habitat**

This alternative would follow the current Forest Plan as amended in 1996, for MSO habitat. It would be similar to Alt 1, except for some differences in owl habitat. See Table 15. There would be no burning in core areas, so fireline would need to be built when nearby areas were burned. There would be a 9” cap in PACs, so basal area, SDI, and TPA would be higher after treatments than in alternative. 1. This could increase the fire and insect outbreak risk. Also, trees would not be able to grow as large (10.9” dbh vs 12.3). Target/threshold stands would be thinned or maintained at a higher basal area (150/170 instead of 120). This means they would still be at a fairly high SDI (47% vs 36%), so the trees would be competing with each other. There would be minimal understory. The predicted effects of this alternative on forest stands are shown in Table 16. There would be about 410 acres treated in PACs, 360 acres in target/threshold, and 6,730 acres of restricted habitat treated to a restoration prescription. The restoration prescription brings the treated stands to 24% of max SDI, giving trees room to grow vigorously. This prescription grows the biggest trees in 20 years (16.4”).

**Effect of Forest Plan Amendments**

The amendment to allow burning in MSO core areas has beneficial effects because it reduces fire danger, and allows the positive effects of fire to occur on more acres.

The amendment to allow work on all MSO PACs has beneficial effects because it will reduce fire danger and allow some restoration, which will help preserve PACs, on more acres. Because mechanical treatments will be limited by topography and access, the primary benefit is being able to use prescribed fire in PACs to reduce surface fuels.

The amendment regarded paired monitoring of PACs will have no effect on forest stands.

The amendments to use the 18” cap, size and basal area direction in the new MSO recovery plan, will have beneficial effects in the PACs and replacement nest/roost habitat because it helps us meet the objective of growing bigger trees faster, and reducing fire danger, as shown in the effects analysis.

The amendment to use “thinning” instead of “thinning from below” will have beneficial effects because it will allow us to create more balanced, uneven age stands by removing small and medium-size trees.

The amendment to work in goshawk nest areas 2 years in a row will have beneficial effects because it allows us to meet our goals sooner.

The amendment regarding interspaces in goshawk stands will have beneficial effects because it clarifies the intent of the Desired Condition for goshawk.

The amendments regarding turkey and peregrine will have beneficial effects because they remove restrictions, which will allow us to reach our goals sooner.

The amendment regarding Viewshed will have no effect on forestry activities.

The amendment regarding VQOs will have beneficial effects, since it will allow restoration work to occur in an area that needs restoration.

**Cumulative Effects**

Past tree cutting, grazing, and fire suppression has created a forest that is unnaturally dense, with uncharacteristic canopy continuity, as described under Existing Condition. Currently, the Valles Caldera
is doing thinning on their forest. Neighboring National Forests are doing restoration work. There is some thinning on some of the adjacent private land. Overall, cumulative effects are minor.

Detailed cumulative effects are shown in the draft EIS, please refer to it.

**Comparison of Effects and Conclusion**

It is possible to make a rough estimate of how much tree volume would be removed over the course of the project, 10 or more years. Volume estimates are approximate, because there are many assumptions about current volume, access, removal methods, and merchantability. Volume was not re-calculated when Alt. 5 was added. The calculated volume was applied to Alt. 5. Then, alternatives 1, 3, and 4 were reduced by 4%, because that is the proportion of acres that would receive a light treatment instead of a restoration treatment, reducing the amount of volume that would be removed.

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Acres Harvest</th>
<th>Total mbf ≥ 9 in.</th>
<th>Total ccf ≥ 5 in.</th>
<th>Total ccf 5-8 in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>31,400</td>
<td>114,000</td>
<td>342,900</td>
<td>115,000</td>
</tr>
<tr>
<td>2</td>
<td>800</td>
<td>4,600</td>
<td>12,500</td>
<td>3,300</td>
</tr>
<tr>
<td>3</td>
<td>29,500</td>
<td>105,600</td>
<td>317,100</td>
<td>105,900</td>
</tr>
<tr>
<td>4</td>
<td>31,400</td>
<td>114,000</td>
<td>342,900</td>
<td>115,000</td>
</tr>
<tr>
<td>5</td>
<td>31,400</td>
<td>118,700</td>
<td>357,200</td>
<td>119,800</td>
</tr>
</tbody>
</table>

Note: acres and volumes rounded to 100
MBF=one thousand board feet. CCF=100 cubic feet
BF merch is 9in/6 in. CF merch is 5 in/4 in. Total CCF is 9 in+

Alternatives 1 and 5 are clearly the most beneficial for achieving forest restoration. They promote ecosystem health and resiliency. While they don’t reach the entire goal of balancing 6 VSS classes, they do move the forest a long ways in that direction, and can move much of the forest from even-aged to uneven aged structure, and set up the forest to be more self-sustaining. They create a mosaic of forest types across the landscape, including old growth, meadows, and aspen stands. They also provide economic opportunity.

The difference between the two alternatives relates to MSO habitat. Both treat the same acres in PACs, but alternative 1 grows bigger trees, has fewer trees/acre, has a more sustainable SDI in PACs. It treats more acres more heavily in the nest/roost area. It treats about 1,300 fewer acres to a restoration goal. Alternative 5 leaves PACs denser, and leaves target/threshold areas denser. It treats 1,300 more acres to a restoration goal. To summarize:

Alt. 1: 2,080 acres of 120 BA with 18” cap 5,410 acres of restoration Rx

Alt. 5: 360 acres of 150+ BA, 410 acres of 150+ BA with 9” cap 6,730 acres of restoration Rx
**Alternative 3** is the next best, achieving the same benefits and effects as described above, but on slightly fewer acres.

**Alternative 4** helps to improve forest condition. It restores structure on all the mechanically treated areas, which reduces fire hazard to some degree. However, it does not restore the beneficial process of fire on those acres. It creates a dilemma in how to handle the fuels/slash that are generated from the thinning; the most obvious solution is mastication, but that can be detrimental to remaining trees, and to the understory. In practice, because additional effort and expense would be required to keep prescribed fire out of treatment acres, it is likely that some un-cut areas would also be excluded from prescribed fire. The benefits of fire are realized on the remaining acres.

**Alternative 2** leaves the forest overstocked, vulnerable to uncharacteristically severe wildfires and insect outbreaks. There is a high probability of an uncharacteristically severe wildfire. This is the least desirable alternative.
References


Federal Register 78 (224). Nov. 20, 2013. Pg. 69573.


USDA Forest Service. 2003. Presentation by NM Zone Insects and Disease Staff.

USDA Forest Service 2005. Letter from NM Zone Insects and Disease Staff.


Vandendriesche, Personal communication.

Youtz, Jim, Gayle Richardson, and Mike Manthei. 2012. Rim Lakes Forest Health Project, Silviculture Specialist Report, Black Mesa Ranger District Apache-Sitgreaves National Forests
Appendix A. Notes on FSVeg SDA Methods and FVS Thinning Simulations

Prepared by: Rob Schantz

**Nearest Neighbor Imputation (NN)**

A computer program called Nearest Neighbor (NN) was used to assign stand exam data (reference stands) to the stands without stand exam data. NN analysis uses satellite imagery (2010 LandSat TM data), spatial relationships, and topographic information to match target stands without data to the most similar reference stand with data. Tree data from the reference stand is then assigned to the target stand without data.

Since there was very little reference data for the piñon-juniper cover type (about 20 stand exams, or 5 percent of cover type area), NN imputation was generally poor in this type. Quality in the ponderosa pine and mixed conifer was good.

**NN Quality**

Reference Stand Info:
Number of reference stands used is: 647
There were 33 notably large differences among reference observations. This represents 5.1 percent of the 647 references.

Threshold value used: 1.71
Imputed Stand Info:
Number of target imputations is: 3365
There were 265 notably large differences between reference and target observations. This represents 7.88 percent of the 3365 imputations.

Total number of forested (reference and imputed) stands: 4012

Percentage of stands:
- Below threshold = 93.39%
- Above threshold = 6.61%

93.39 of the stands were well represented by the imputation run. The remaining percentage did not have similar reference stands, hence all available reference options could be statistically poor. These stands will be displayed as 'Poor' on the map.

**Prescription Assignment**

**Time Frame**

The simulations begin in the year 2014 and were modeled for 30 years through 2044. Effects of treatments appear in the output tables in 2017, when all thinning and burning activities are assumed to be complete.

**Potential Harvest**

The project layers for potential layers by alternative were used to assign the thinning prescriptions in SDA. The potential harvest layers were first intersected with the stand (NRIS VegPoly) layers, and polygon slivers less than two acres deleted, in order to get the cut-polygons tool in SDA to work- this
resulted in the loss of about 250 acres for the potential harvest. After the cut-polygons operation was run to integrate the harvest units into the stand layer, the prescriptions were assigned using the ArcMap “select by location” method and visual inspection.

Alternatives 1 and 4 have the same potential harvest (thinning) footprint. Alternative 3 has about 1900 acres less thinning due to reduction in temporary roads. The No Action alternative (Alternative 2) has a thinning footprint of about 850 acres in previously planned projects.

Thinning was scheduled in 2014 using the ThinPt keyword with an SDI target, except in MSO PACs where the ThinBBA keyword and a basal area target was used. Thinning MSO target/threshold stands represented only about 400 acres, and therefore no separate thinning regime was simulated for them. Table 1 lists the thinning targets used in the simulations. Thinning slash was assumed to be left in the woods using the YardLoss keyword. In alternatives 1, 2, and 3 thinning was followed by a pile burn in 2015 and an underburn in 2016. In Alternative 4, the slash was left untreated (no pile burn or underburn).

The point-thinning method used (ThinPt keyword) thins each sample point in a stand to the residual target. This means that dense areas in the stand are thinning to the target density, while areas already below the target are not thinned. This method is more representative of how stands are actually thinned in practice. The end result is that since the denser sample points are thinned to the target density the overall stand average is usually below the residual target due to sample points falling in under-stocked areas and openings.

Table 1 FVS thinning

<table>
<thead>
<tr>
<th>Prescription</th>
<th>Thinning Keywords</th>
<th>SDI Target</th>
<th>Basal Area Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>UEA</td>
<td>ThinPt, ThinSD</td>
<td>113</td>
<td>-</td>
</tr>
<tr>
<td>UEA_NGH_PFA</td>
<td>ThinPt, ThinSD</td>
<td>135</td>
<td>-</td>
</tr>
<tr>
<td>DMC_UEA</td>
<td>ThinPt, ThinSD</td>
<td>165</td>
<td>-</td>
</tr>
<tr>
<td>DMC_UEA_NGH_PFA</td>
<td>ThinPt, ThinSD</td>
<td>189</td>
<td>-</td>
</tr>
<tr>
<td>MMC_UEA</td>
<td>ThinPt, ThinSD</td>
<td>223</td>
<td>-</td>
</tr>
<tr>
<td>SI</td>
<td>ThinPt, ThinSD</td>
<td>90</td>
<td>-</td>
</tr>
<tr>
<td>UEA_MSKO_PAC</td>
<td>ThinPt, ThinBBA</td>
<td>-</td>
<td>150</td>
</tr>
<tr>
<td>DMC_UEA_MSKO_PAC</td>
<td>ThinPt, ThinBBA</td>
<td>-</td>
<td>150</td>
</tr>
</tbody>
</table>

Point thinning in FVS better simulates how stands would be marked in practice, because when we mark a stand the dense areas are thinned to the target residual density while areas below the target are not thinned or only thinned lightly to create more heterogeneity. This method also leaves smaller trees in the FVS tree list where they constitute the stocking, versus the normal FVS thin-from-below method where the smallest trees are removed until the desired target density is achieved. With point-thinning, the desired condition for density in effect applies to the dense tree groups or areas currently above the target- this is what we want to achieve in practice to allow these groups to grow and maintain vigor against bark beetles, fire, and dwarf mistletoe.
The result of using the point thinning method in terms of post-thinning stand metrics is that the post-stand averages fall below the desired target. This is because if the dense areas are thinned to the target and other areas are already below the target, then the average stand is always below the target. However, this is more reflective of real situations, and is actually what we want in terms of creating heterogeneous stands.

Some other factors and limitations of the model to consider in interpreting results are:

- The existing condition for MSO PACs on a stand-average basis is already below the desired basal area of 150 square ft.
- No dbh limit to tree removal was applied, although we know that in actual marking practice we will be giving special attention to larger trees, especially within PACs, PFAs, target/threshold, and old-growth. It is impossible to model the numerous site-specific situations that would occur during actual stand marking/cutting, such as leaving a large PP with a high mistletoe rating by creating an open swath around it or leaving DF instead of PP around it.
- A preference for PP was applied so the model would in some cases (depending on the dbh difference) choose for retention a smaller PP over a larger fir-this may not be what we want in all cases when marking MSO habitat, but we do want to increase the proportion of PP over the landscape. A preference was given to removal of trees with dwarf mistletoe ratings of 4-5-6; since PP is the species with the worst mistletoe infection (in general) the model may have done some thinning from above to leave trees with a lower rating. Both of these factors would potentially affect the percentage of trees greater than 16 in. dbh that were removed in the simulations.
- In actual marking practice, leave basal area on the edges of tree groups/clumps would be higher because trees along the edges of opening can utilize the additional growing space
- The limitations noted above lead to an overestimate of number of trees 16 inches and larger that would be removed in practice
- The prescribed underburns modeled in FVS further reduced stand density from the target in thinned stands due to model-estimated mortality from bole/crown scorch. However, we want to re-introduce fire to these types because of its tangible and intangible benefits.

For Alternative 1 (Proposed Action) there are 31,417 acres in the potential harvest layer. In SDA, 31,090 were assigned a thinning prescription, and FVS actually thinned and harvested trees from 30,314 acres. Areas without stand exams (i.e. non-forest types as coded in FSVeg) cannot be assigned an activity in SDA, hence some harvest areas were not assignable and some stand exam data indicated that the stand was already below the thinning target.

The pile burn (PileBurn keyword) was assigned to treat most of the thinning-generated slash from processing tops in the woods. It was assumed that fuel would be collected from 80 percent of the stand area and put into piles covering 15 percent of the stand area- 85 percent of the fuel would be removed in the area of collection. Mortality from the burning was assumed to be 1 percent.

The underburn follows the pile burn (SimFire keyword). Wind was assumed to be 5 mph, temperature 70 degrees F, area burned 70 percent, and a fall burn. Mortality was estimated by the FFE model.
Prescribed Fire

Prescribed fire (underburning) was assigned using the project layers. As noted above, underburning was assigned post-thinning and pile burning in potential harvest units for alternatives 1, 2, and 3. In Alternative 4 no underburning or pile burning was assigned within the harvest units.

Areas outside of harvest units were assigned an underburn using the SimFire keyword with the same parameters as noted above for the harvest units. Areas without stand exams (i.e. non-forest types) cannot be assigned an activity in SDA, hence no underburn was assignable to some areas in the project Prescribed Fire layers.

Fire Modeling with FVS-FFE

Fire modeling in FVS-FFE used the 53 fuel model logic, and FFE was left to select fuel models pre- and post-treatment. The same fuel and weather conditions were put into FFE as were used in the FlamMap modeling. Conditions were based on severe fire weather and fuel conditions, such as occurred during the Las Conchas Fire of 2011. Table 2 list the parameters used.

Table 2 Fuel and weather parameters recorded by Tower RAWS during Las Conchas Fire- used in fire behavior modeling

<table>
<thead>
<tr>
<th>Fuel Component</th>
<th>Percent Moisture Content</th>
<th>Weather Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-hour Time lag</td>
<td>1.00</td>
<td>Temperature</td>
<td>94 Degrees F</td>
</tr>
<tr>
<td>10-hour Time lag</td>
<td>1.00</td>
<td>Rel. Humidity</td>
<td>5%</td>
</tr>
<tr>
<td>100-hour Time lag</td>
<td>2.00</td>
<td>Wind</td>
<td>19 mph</td>
</tr>
<tr>
<td>1000-hour Time lag</td>
<td>4.00</td>
<td>% Area Burned</td>
<td>80</td>
</tr>
<tr>
<td>Live woody Fuels</td>
<td>60</td>
<td>Season of Fire</td>
<td>2 – Before Greenup</td>
</tr>
<tr>
<td>Herbaceous</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duff</td>
<td>20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Products

The following output products were used in the analysis of alternatives:

1. Stand density metrics
2. Thinning removals by size class
3. CBH, CBD, CC, stand height, and fuel models
4. Potential fire metrics, including potential smoke
5. Fuel consumption from pile burning and underburning
Methods for Analyzing Alternative 5

Make no changes to the Rx in Restricted/Recovery habitat for both alternatives. Even though there is a 24” cap and it wasn’t previously modeled, the two alternatives would be the same effect.

Under the new recovery plan, we would use 120 BA and 18” cap in PACs and nest/roost, assuming the conditions defined for Recovery Nest/Roost (replacement nesting habitat) would characterize conditions for current nesting habitat.

Under the current forest plan/old recovery plan, we would use 9” and 150 BA in PACs. In Threshold, use a 150 BA also; it is too complicated to worry about the 150/170 split.
Appendix B
Old Growth Allocations

Legend
- PPold_growth
- MCold_growth

1:170,000